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NEW LOWER PERMIAN FUSULINIDS FROM CULBERSON COUNTY, TEXAS

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ABSTRACT

Six collections from the lower part of the Lower Permian Bone Spring Formation (Leonardian) were obtained from the east side of hill 4410, immediately west of the northwest corner of the Baylor Mountains, Culberson County, Texas. In addition to *Parafusulina (Skinnerella) schucherti* DUNBAR & SKINNER and *P. (S.) diabloensis* DUNBAR & SKINNER, these collections contain eight new species of *Parafusulina (Skinnerella)* and one new species of *Parafusulina (Parafusulina)* which are described here. These are distributed through the basal 125 feet of the Bone Spring Formation as it is exposed at this place.

INTRODUCTION

The Bone Spring Formation of the Sierra Diablo has been considered to be the equivalent of the Skinner Ranch and Cathedral Mountain formations of the Glass Mountains (Leonard Formation of earlier reports). Accumulating evidence during the past few years, however, rather strongly indicates that the upper part of the Bone Spring Formation may be equivalent to at least a part of the Road Canyon Formation of the Glass Mountains (lower part of the Word Formation of earlier reports). The base of the Bone Spring Formation varies slightly in age from place to place because of its unconformable relationship to the underlying Hueco Formation, but it falls within the limits of the lower Leonardian wherever it is exposed in the Sierra Diablo or the Baylor Mountains.

The collections upon which this paper is based were obtained from the east slope of hill 4410, located immediately west of the northwest corner of the Baylor Mountains and just west of Texas State Highway No. 54, north of Van Horn, Culberson County, Texas. The lower part of the hill is occupied by the uppermost beds of the Hueco Formation, the top of which forms a prominent bench on the east side of the hill. The slope above the Hueco strata is broken by two pairs of prominent limestone ledges, and the hill is capped by a massively bedded cliff-forming limestone. The comparatively smooth slopes between these ledges are occupied by poorly exposed silty thin-bedded limestones.

The basal part of the Leonard Series, that is, the zone of *Schwagerina crassitectoria,* is missing here and the upper part of the zone of *Parafusulina (Skinnerella) schucherti* and *P. (S) diabloensis* rests directly upon the Hueco Formation. The base of the lower limestone of the first pair of prominent ledges is about 40 feet above the top of the Hueco Formation. This limestone is approximately 10 feet thick and is separated from the upper limestone of this pair, which is also about 10 feet thick, by some 15 feet of poorly exposed silty thin-bedded limestone. The base of the lower limestone of the second pair is about 30 feet higher in the section, or about 105 feet above the top of the Hueco Formation. This second pair of prominent ledges, together with the thin interval

of thin-bedded limestone which separates them, aggregate about 20 feet of section. Above this pair of ledges is a relatively smooth slope, terminated by the cliff-forming limestone which caps the hill. According to P. B. KING & J. B. KNIGHT (U.S.G.S. Oil and Gas Investigations Preliminary Map 2), the relatively smooth slopes represent the basin facies of the Bone Spring Formation, whereas the prominent ledges are tongues of shelf facies which coalesce westward into massive light-colored limestone.

I express my thanks to the Humble Oil & Refining Company for permission to publish this paper.

All figured holotypes and paratypes will be deposited in the collections of the Paleontological Institute of the University of Kansas, Lawrence, Kansas (KUMIP—Kansas University Museum of Invertebrate Paleontology).

FUSULINID COLLECTIONS

All collections were obtained from the east slope of hill 4410, immediately west of Texas State Highway 54 and just west of the northwest corner of the Baylor Mountains, Culberson County, Texas.

COLL. T-1005. Bone Spring Formation. Base of lower pair of prominent limestone ledges and about 40 feet above top of the Hueco Formation.

COLL. T-1006. Bone Spring Formation. Top of lower member of lower pair of prominent limestones and about 10 feet above T-1005.

COLLS. T-537 and T-1007. Bone Spring Formation. Top of upper member of lower pair of limestones and about 25 feet above T-1006.

COLL. T-1008. Bone Spring Formation. Base of lower member of upper pair of prominent limestone ledges and about 30 feet above T-537 and T-1007.

COLL. T-538. Bone Spring Formation. Top of upper member of upper pair of limestones and about 20 feet above T-1008.

Parafusulina (*Skinnerella*) *schucherti* DUNBAR & SKINNER is present in collections T-537, T-538, T-1005, and T-1006, and *P.* (*S.*) *diabloensis* DUNBAR & SKINNER is present in collections T-1005 and T-1006. Neither of these species is described in the present report.

SYSTEMATIC PALEONTOLOGY

Family FUSULINIDAE von Möller, 1878

Subfamily SCHWAGERININAE Dunbar & Henbest, 1930

Genus PARAFUSULINA Dunbar & Skinner, 1931

Subgenus SKINNERELLA Coogan, 1960, emend. Skinner

ORIGINAL DIAGNOSIS.—Species of the genus *Parafusulina* characterized by fusiform to fusiform-elongate shells and cuniculi in an early stage of development, restricted to the outer few volutions. The axis of coiling is generally straight, the proloculus small to medium size for the genus and the form ratio is small.

TYPE-SPECIES.—*Parafusulina schucherti* DUNBAR & SKINNER, 1937, Univ. Texas Bull. 3701, p. 672-674, pl. 64, fig. 9-12.

DISCUSSION.—COOGAN (1960) proposed *Skinnerella* as a subgenus of *Parafusulina,* and included in it, in addition to the type-species, the West Texas species *Parafusulina diabloensis* DUNBAR & SKINNER, *P. bakeri* DUNBAR & SKINNER, and *P. fountaini* DUNBAR & SKINNER, as well as a number of species from other areas. Although a study of topotype specimens indicates that *P. diabloensis* is closely related to *P. schucherti,* and therefore should be included in this subgenus, *P. bakeri* and *P. fountaini* appear to be typical representatives of *Parafusulina* (*Parafusulina*).

A consideration of *Parafusulina schucherti, P. diabloensis,* and related species leads me to the belief that they constitute a distinct group in a lineage that branched off the main line of *Schwagerina-Parafusulina* evolution in late Wolfcampian or early Leonardian time, and died out near the middle of Guadalupian time. This branch begins with species of the general type of *Schwagerina crassitectoria* DUNBAR & SKINNER, evolves through *Parafusulina* (*Skinnerella*), and culminates in *Skinnerina* Ross.

All species of this lineage have two characteristics in common, the presence of more or less well-developed axial filling and a peculiar type of septal fluting which produces, as seen in axial sections and particularly in the central portion of the shell, high septal loops which are squared off at

the tops rather than being rounded. These peculiar loops are frequently wider at the top than base, producing a mushroom-shaped outline. The axial filling causes many of the loops to appear greatly thickened across the top where sections pass through the septum obliquely.

In species of *Schwagerina* belonging to this branch and in *Parafusulina* (*Skinnerella*) phrenothecae are commonly well developed. Sporadic cuniculi may be present adjacent to the tunnel in the outer whorls of such species of *Schwagerina.* In *Parafusulina* (*Skinnerella*) low narrow cuniculi are invariably present in the outer whorls, especially in the middle part of the shell.

In *Skinnerina,* the culmination of this lineage, sporadic supplementary tunnels are added, while the median tunnel is no longer well defined and is sporadic in its occurrence; it may be present in some whorls and absent in others in the same specimen. This sporadic occurrence of the median tunnel is one of the principal characters which distinguish *Skinnerina* from *Polydiexodina;* in the latter the central tunnel is always well developed and continuous. In addition, the supplementary tunnels of *Polydiexodina,* once they appear, are continuous into the final volution, whereas those of *Skinnerina* seldom continue for more than two whorls and commonly do not extend for even a full volution.

One other feature which *Parafusulina* (*Skinnerella*) and *Skinnerina* have in common, and which distinguishes them from *Parafusulina* (*Parafusulina*) and *Polydiexodina,* respectively, is the nature of their microspheric specimens. In *Parafusulina* (*Parafusulina*) and *Polydiexodina* the microspheric individuals are giants, being two or more times as large as their megalospheric counterparts, and no tunnel or tunnels have been observed outside the juvenarium. By contrast, the microspheric specimens of *Parafusulina* (*Skinnerella*) and *Skinnerina* are little, if any, larger than the corresponding megalospheric individuals, and the development of the tunnel or tunnels is identical with that of the latter.

Since it appears that *Parafusulina* (*Skinnerella*) is not directly related to *Parafusulina* (*Parafusulina*), except in being derived from a common ancestral form, it might be argued that the former should not be regarded as a subgenus of *Parafusulina.* For the present, however, I am following Coogan's classification.

Emended Diagnosis.—Shells commonly thickly fusiform to elongate fusiform, rarely subcylindrical, of medium to large size; spirotheca, consisting of tectum and keriotheca, usually rather thin; septa intensely and regularly fluted in such manner that septal loops, as seen in axial sections, are commonly squared off across the tops and are commonly wider at the top than at the base, especially in the middle part of the shell; axial filling usually well developed, particularly adjacent to the tunnel, consisting of secondary deposits on both anterior and posterior surfaces of septa; secondary deposits commonly cause septal loops, as seen in axial sections, to appear greatly thickened at tops where plane of section crosses them obliquely; low narrow cuniculi present in outer whorls, particularly in middle part of shell; phrenotheca usually well developed; proloculus moderate in size to large; chomata present only on proloculus; tunnel singular. Microspheric specimens about same in size as their megalospheric counterparts, differing from latter only in having greater number of whorls, minute proloculus, and discoidal juvenarium consisting of 2 or 3 whorls coiled askew to outer volutions; median tunnel well developed.

Type-Species.—*Parafusulina schucherti* Dunbar & Skinner.

Age.—Leonardian (Early Permian).

PARAFUSULINA (SKINNERELLA) MAGNA
Skinner, n. sp.

Plate 1, figures 1-3; Plate 2, figures 1-5

Shell large, thickly subcylindrical, some specimens slightly constricted in middle, with bluntly rounded poles. Mature specimens have 8 to 10 whorls and measure 17.6 to 19.7 mm in length, and 3.8 to 4.5 mm in diameter. Form ratio varies from 3.91 to 4.89, averaging about 4.45.

Spirotheca composed of tectum and keriotheca; in the 8th volution its thickness measures 65 to 78 μ. Septa intensely fluted throughout shell; septal folds high, commonly extending to tops of chambers; septal loops as seen in axial section commonly wider at top than base, producing mushroom-shaped outline, particularly in middle part of shell. Septa number 14 to 16 in 1st whorl, 25 to 30 in 2nd, 31 to 32 in 3rd, 34 to 35 in 4th, 33 to 47 in 5th, 38 to 48 in 6th, 40 to 48 in 7th, and 43 to 47 in 8th. Secondary deposits coat both surfaces of septa in 2 zones on either side of tunnel, commonly nearly filling shell in first 4 to 5 volutions. In some specimens (Pl. 1, fig. 3) additional sec-

ondary deposits are present in the poles of each whorl. In zones near tunnel secondary deposits cause the septal loops to appear greatly thickened across the top. Phrenothecae moderately developed. Low narrow cuniculi present in outer whorls, especially in middle part of shell.

Proloculus moderately large, its outside diameter ranging from 255 to 359 μ, averaging about 290 μ. Tunnel rather narrow, tunnel angle measuring 33° to 37° in eighth volution. Chomata present only on proloculus.

A single observed microspheric specimen (Pl. 2, fig. 2) has 12 volutions and measures 15.0 mm in length and 3.7 mm in diameter, giving a form ratio of 4.05. The first 2 whorls are discoidal and coiled askew to the later ones. The early volutions are tightly coiled, and the spirotheca is markedly thinner than in corresponding whorls of megalospheric specimens. In the 8th volution the spirotheca is only 32 μ in thickness. Fluting of septa and development of secondary deposits comparable to those in megalospheric individuals. Proloculus minute, its outside diameter measuring only 30 μ. Tunnel developed as in megalospheric specimens, in 8th whorl tunnel angle measures 38°. Chomata present only in discoidal juvenarium.

Discussion.—*Parafusulina* (*Skinnerella*) *magna* Skinner, n. sp., is one of the largest members of the genus presently known. It most nearly resembles *P.* (*S.*) *cylindrica* Skinner, n. sp., differing from the latter in its greater diameter for a given number of whorls, smaller form ratio, more numerous septa, and narrower tunnel.

Occurrence.—This species is common in collections T-537, T-538 and T-1007.

Types.—Holotype, KUMIP 2,503,142 (Pl. 1, fig. 1). Paratypes, KUMIP 2,503,143-4 (Pl. 1, fig. 2-3); KUMIP 2,503,145-9 (Pl. 2, fig. 1-5).

PARAFUSULINA (SKINNERELLA) CYLINDRICA Skinner, n. sp.

Plate 3, figures 1-3; Plate 4, figures 1-3; Plate 5, figures 1-4; Plate 6, figures 1-4; Plate 7, figures 1-6

Shell large, subcylindrical, with bluntly rounded poles. Mature individuals have 8 to 9 whorls and measure 16.4 to 20.5 mm in length, and 3.3 to 3.9 mm in diameter. Form ratio ranges from 4.62 to 5.58, averaging about 5.10. Axis of coiling commonly slightly curved.

Spirotheca, composed of tectum and keriotheca, measures 66 to 76 μ in thickness in the 8th volution. Septa intensely fluted throughout shell; septal folds high, commonly extending nearly to tops of chambers, particularly in polar regions. Secondary deposits coat both faces of septa in rather narrow zones on either side of tunnel; in these zones septal loops, as seen in axial section, commonly appear squared off and thickened across tops. Septa number 11 to 15 in 1st volution, 18 to 21 in 2nd, 19 to 25 in 3rd, 27 to 30 in 4th, 28 to 35 in 5th, 30 to 36 in the 6th, 33 to 39 in 7th, 38 to 42 in 8th, and about 49 in 9th. Phrenothecae moderately developed. Low narrow cuniculi present in outer whorls, particularly in middle part of shell.

Proloculus rather variable in size, its outside diameter ranging from 268 to 452 μ, averaging about 350 μ. Tunnel broad, tunnel angle measuring 53° to 61° in 8th volution. Chomata present only on proloculus.

Three axial sections of microspheric individuals have 11.5 to 12 whorls and measure 15.0 to 19.5 mm in length, and 3.4 to 3.6 mm in diameter, with form ratio varying from 4.41 to 5.42. First 2 whorls constitute a discoidal juvenarium coiled askew to later whorls. Early volutions tightly coiled, and spirotheca markedly thinner than in megalospheric specimens; thickness of spirotheca in 8th volution measures 37 to 49 μ. Fluting of septa similar to that of megalospheric individuals, but development of secondary deposits much greater, nearly filling shell on either side of tunnel. Proloculus minute, its outside diameter measuring 29 to 37 μ. Tunnel developed throughout growth of shell as in megalospheric forms but narrower, tunnel angle in 8th whorl measuring 27° to 33°. Chomata present only in juvenarium.

Discussion.—*Parafusulina* (*Skinnerella*) *cylindrica* Skinner, n. sp., is one of the largest species of the genus presently known. It most closely resembles *P.* (*S.*) *magna* Skinner, n. sp., from which it differs in its larger form ratio, less numerous septa, and wider tunnel. In addition, *P.* (*S.*) *cylindrica* commonly has a somewhat larger proloculus than *P.* (*S.*) *magna,* and the secondary deposits are less well developed in the megalospheric form.

Occurrence.—This species is common in collections T-537, T-538, T-1005, and T-1007, and abundant in collection T-1008.

Types.—Holotype, KUMIP 2,503,150 (Pl. 3, fig. 1). Paratypes, KUMIP 2,503,151-62; 2,503,220

(Pl. 3, fig. 2-3; Pl. 4, fig. 1-3; Pl. 5, fig. 1-4; Pl. 6, fig. 1-4; Pl. 7, fig. 1-6).

PARAFUSULINA (SKINNERELLA) FORMOSA
Skinner, n. sp.

Plate 8, figures 1-3; Plate 9, figures 1-5

Shell large, elongate fusiform to subcylindrical, with bluntly pointed to rounded poles. Fully grown individuals have 6 to 7 volutions and measure 12.5 to 15.9 mm in length, and 3.5 to 4.1 mm in diameter. Form ratio varies from 3.55 to 3.98, averaging about 3.75.

Spirotheca composed of tectum and keriotheca; in 6th whorl it measures 59 to 86 μ in thickness, averaging about 75 μ. Septa intensely fluted from pole to pole; septal folds high, commonly reaching tops of chambers. Secondary deposits coat both surfaces of septa in relatively narrow zones on either side of tunnel; in these areas septal loops, as seen in axial section, appear squared off and thickened across tops; septal loops frequently wider at tops than at bases, producing mushroom-shaped outline. Septa number 15 to 19 in 1st whorl, 24 to 28 in 2nd, 29 to 39 in 3rd, 35 to 40 in 4th, 34 to 44 in 5th, and 41 to 45 in 6th. Low narrow cuniculi developed in outer whorls, particularly adjacent to tunnel. Phrenothecae well developed.

Proloculus large, its outside diameter varying from 451 to 721 μ, averaging about 580 μ. Tunnel rather narrow, tunnel angle ranging from 33° to 44° in the sixth whorl. Chomata present only on proloculus.

Discussion.—*Parafusulina* (*Skinnerella*) *formosa* Skinner, n. sp., does not closely resemble any other known species of this genus. In size and shape it is comparable to *P.* (*S.*) *schucherti* Dunbar & Skinner, but the smaller proloculus and much greater development of secondary deposits in the latter readily distinguish the 2 species.

Occurrence.—This species is common in collections T-537, T-538, T-1005, and T-1006.

Types.—Holotype, KUMIP 2,503,163 (Pl. 8, fig. 1). Paratypes, KUMIP 2,503,164-70 (Pl. 8, fig. 2-3; Pl. 9, fig. 1-5).

PARAFUSULINA (SKINNERELLA) TENUIS
Skinner, n. sp.

Plate 10, figures 1-4; Plate 11, figures 1-2

Shell large, elongate, slender subcylindrical, with bluntly pointed to rounded poles. Mature specimens have 8 to 9 volutions and measure 14.6 to 17.0 mm in length, and 2.6 to 3.0 mm in diameter. Form ratio large, varying from 4.87 to 6.00, averaging about 5.65.

Spirotheca, composed of tectum and keriotheca, varies from 46 to 66 μ in thickness in the 8th whorl. Septa strongly fluted from pole to pole; septal folds high, commonly reaching tops of chambers in polar regions. Secondary deposits variable in development, commonly coating septa thinly in narrow zones on either side of tunnel, but in some specimens nearly filling shell in early volutions. Septal loops in middle of shell, as seen in axial sections, appear squared off and thickened across tops. Septa number 10 to 14 in 1st volution, 14 to 26 in 2nd, 25 to 27 in 3rd, 26 to 31 in 4th, 30 to 32 in 5th, about 38 in 6th, 43 in 7th, and 45 in 8th. Low, narrow cuniculi are present in the outer whorls, especially in the middle portion of the shell. Phrenothecae present, but only weakly developed.

Proloculus small for members of this genus, its outside diameter measuring 210 to 275 μ, averaging about 237 μ. Tunnel moderately wide, tunnel angle measuring 43° to 45° in the 8th volution. Chomata present only on proloculus.

Discussion.—*Parafusulina* (*Skinnerella*) *tenuis* Skinner, n. sp., is readily distinguished from all other known members of the genus by its tight coiling and very slender shape. In addition, its proloculus is smaller than that of most species of the genus; the only other known species of this group with a comparable proloculus is *P.* (*S.*) *biconica* Skinner, n. sp., and that species differs greatly in general appearance.

Occurrence.—This is a comparatively rare species, only a few specimens having been found in collections T-537, T-538, T-1005, T-1007 and T-1008.

Types.—Holotype, KUMIP 2,503,171 (Pl. 10, fig. 1). Paratypes, KUMIP 2,503,172-6 (Pl. 10, fig. 2-4; Pl. 11, fig. 1-2).

PARAFUSULINA (SKINNERELLA) ROBUSTA
Skinner, n. sp.

Plate 11, figures 3-4; Plate 12, figures 1-4; Plate 13, figures 1-3

Shell large, thickly fusiform, with slightly concave to slightly convex lateral slopes and bluntly pointed poles. Fully grown specimens have 8 to 9 volutions and measure 14.4 to 17.9 mm in length, and 4.6 to 5.7 mm in diameter. Form ratio ranges from 3.13 to 3.33.

Spirotheca, composed of tectum and keriotheca, measures 85 to 98 μ in thickness in the 7th whorl. Septa intensely fluted throughout shell; septal folds high, commonly extending nearly to tops of chambers. Secondary deposits, coating both anterior and posterior surfaces of septa, strongly developed in zones on either side of the tunnel and, in some specimens, extending along narrow zone following axis of coiling. In middle portion of shell septal loops, as seen in axial section, appear squared off and greatly thickened across tops; they are commonly wider at top than at base, producing a mushroom-shaped outline. Septa number 18 to 20 in 1st volution, 24 to 30 in 2nd, 27 to 34 in 3rd, 30 to 43 in 4th, 38 to 46 in 5th, 36 to 43 in 6th, 35 to 47 in 7th, and about 50 in 8th. Low narrow cuniculi are present in the middle portion of the outer whorls. Phrenothecae are moderately to well developed.

Proloculus large, its outside diameter ranging from 396 to 606 μ, averaging about 485 μ. Tunnel narrow, tunnel angle measuring 25° to 32° in 7th volution. Chomata present only on proloculus.

Discussion. — *Parafusulina* (*Skinnerella*) *robusta* Skinner, n. sp., is similar to *P.* (*S.*) *brevis* Skinner, n. sp., but differs from the latter in its larger size, larger form ratio, greater number of whorls, and generally smaller proloculus. In shape it resembles *P.* (*S.*) *diabloensis* Dunbar & Skinner, but it is larger than that species, and its secondary deposits are much less well developed. This species also resembles *P.* (*S.*) *imlayi* Dunbar and *P.* (*S.*) *sonoraensis* Dunbar from Sonora, Mexico, differing from the former in its larger proloculus, thinner spirotheca, and more numerous septa, and from the latter in its markedly larger size for the same number of volutions.

Occurrence.—This species is common in collections T-537, T-538, T-1005, and T-1007.

Types.—Holotype, KUMIP 2,503,177 (Pl. 11, fig. 3). Paratypes, KUMIP 2,503,178-85 (Pl. 11, fig. 4; Pl. 12, fig. 1-4; Pl. 13, fig. 1-3).

EXPLANATION OF PLATES

All figures are unretouched photographs, ×10 except as otherwise indicated. Specimen catalogue numbers are assigned in KUMIP (Kansas University Museum of Invertebrate Paleontology).

PLATE 1

FIGURE

1-3. *Parafusulina* (*Skinnerella*) *magna* Skinner, n. sp.——1. Axial section of holotype 2,503,-142 from coll. T-538.——2-3. Axial sections of paratypes 2,503,143-4, from coll. T-537.

PLATE 2

FIGURE

1-5. *Parafusulina* (*Skinnerella*) *magna* Skinner, n. sp.——1-2. Axial sections of megalospheric and microspheric paratypes 2,503,145-6, from coll. T-537, with retention of tunnel in latter small specimen.——3-5. Sagittal sections of paratypes 2,503,147-9, 3 from coll. T-538, 4-5 from coll. T-537.

PLATE 3

FIGURE

1-3. *Parafusulina* (*Skinnerella*) *cylindrica* Skinner, n. sp.——1. Axial section of holotype, 2,503,150.——2-3. Axial sections of paratypes 2,503,151-2. All from coll. T-1008.

PLATE 4

FIGURE

1-3. *Parafusulina* (*Skinnerella*) *cylindrica* Skinner, n. sp. Axial sections of paratypes 2,503,-153-5; 1 from coll. T-1008; 2 from coll. T-1007; 3 from coll. T-1005.

PLATE 5

FIGURE

1-4. *Parafusulina* (*Skinnerella*) *cylindrica* Skinner, n. sp.——1. Axial section of megalospheric paratype 2,503,156, from coll. T-1007. ——2-4. Axial section of microspheric paratype 2,503,157, ×10, ×40, and ×100, respectively, from coll. T-1008.

PLATE 6

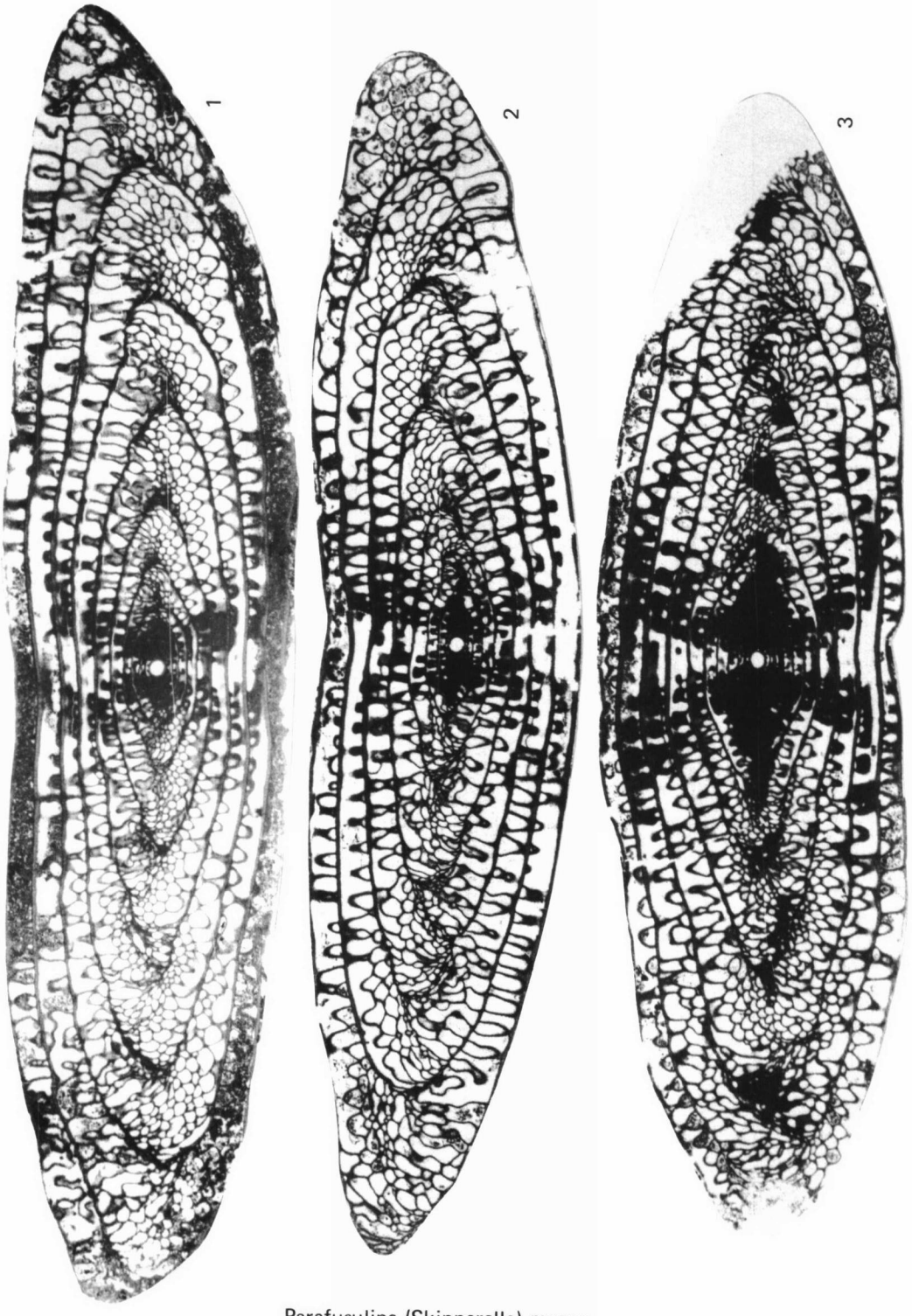
FIGURE

1-4. *Parafusulina* (*Skinnerella*) *cylindrica* Skinner, n. sp.——1-2. Axial sections of microspheric paratypes 2,503,158-9.——3-4. Part of the specimen shown in 1, ×40 and ×100, respectively. 1, 3-4 from coll. T-1008; 2 from coll. T-1007.

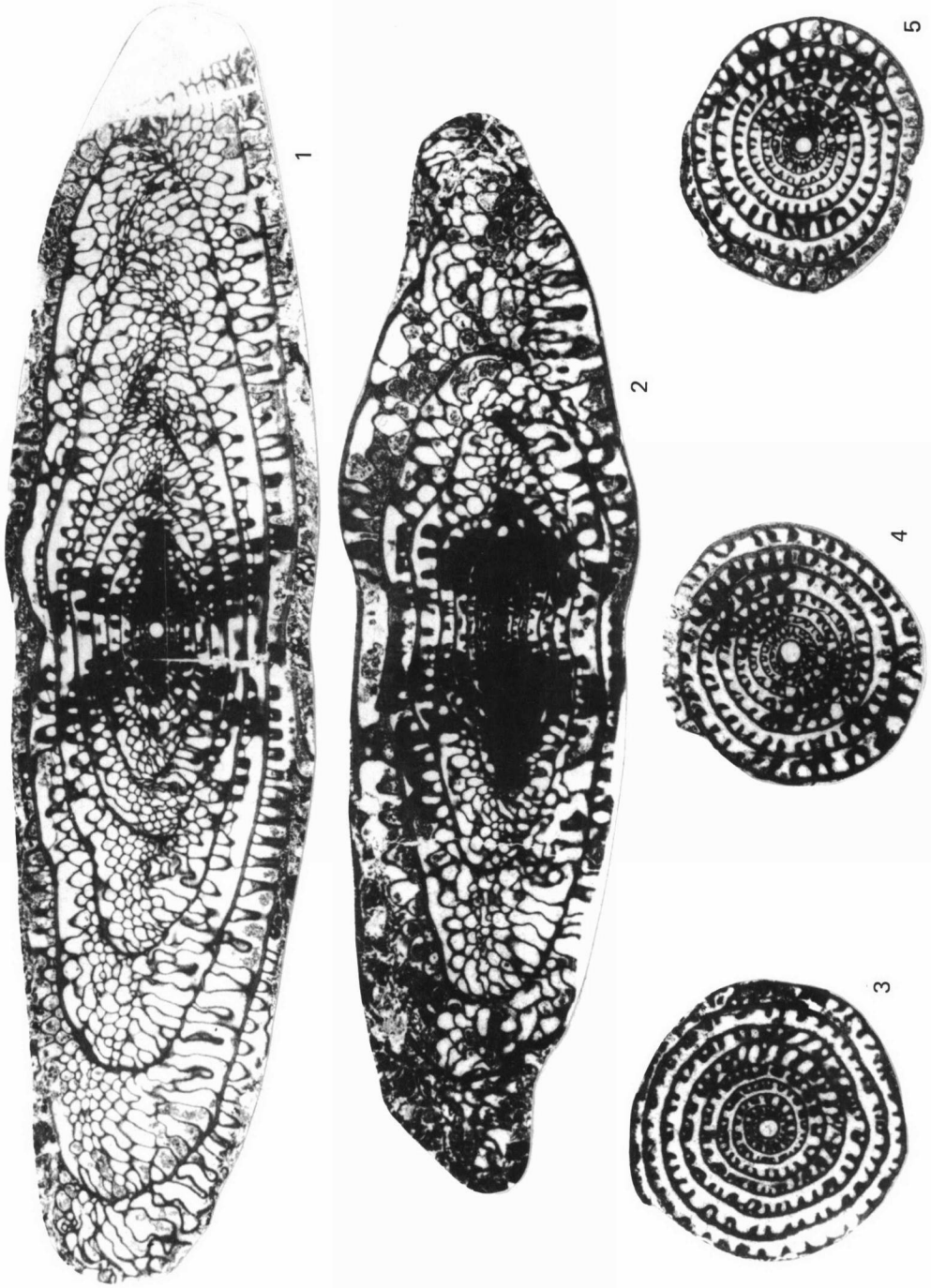
PLATE 7

FIGURE

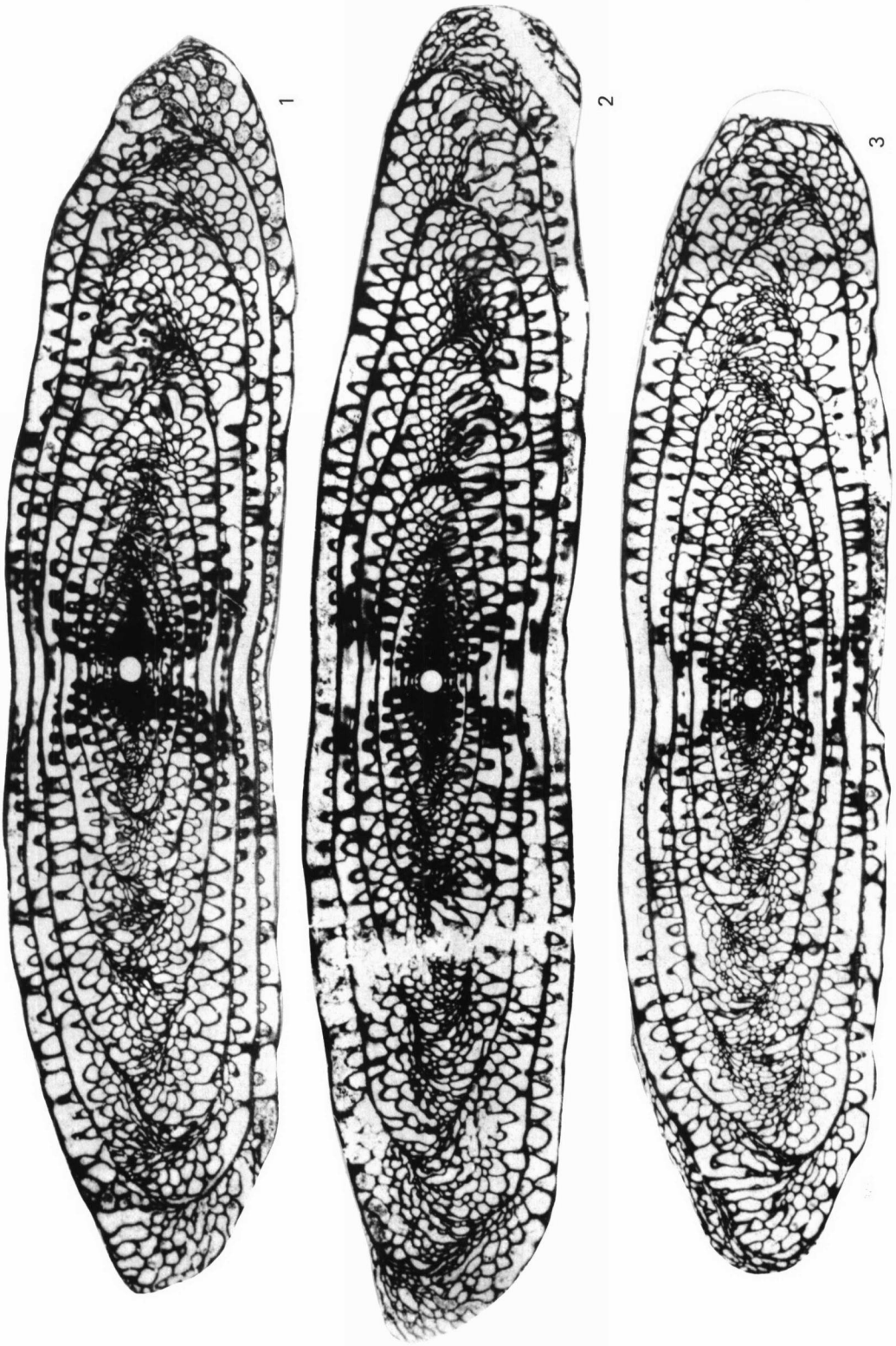
1-6. *Parafusulina* (*Skinnerella*) *cylindrica* Skinner, n. sp.——1-2. Part of specimen shown in Plate 6, figure 2, ×40 and ×100, respec-



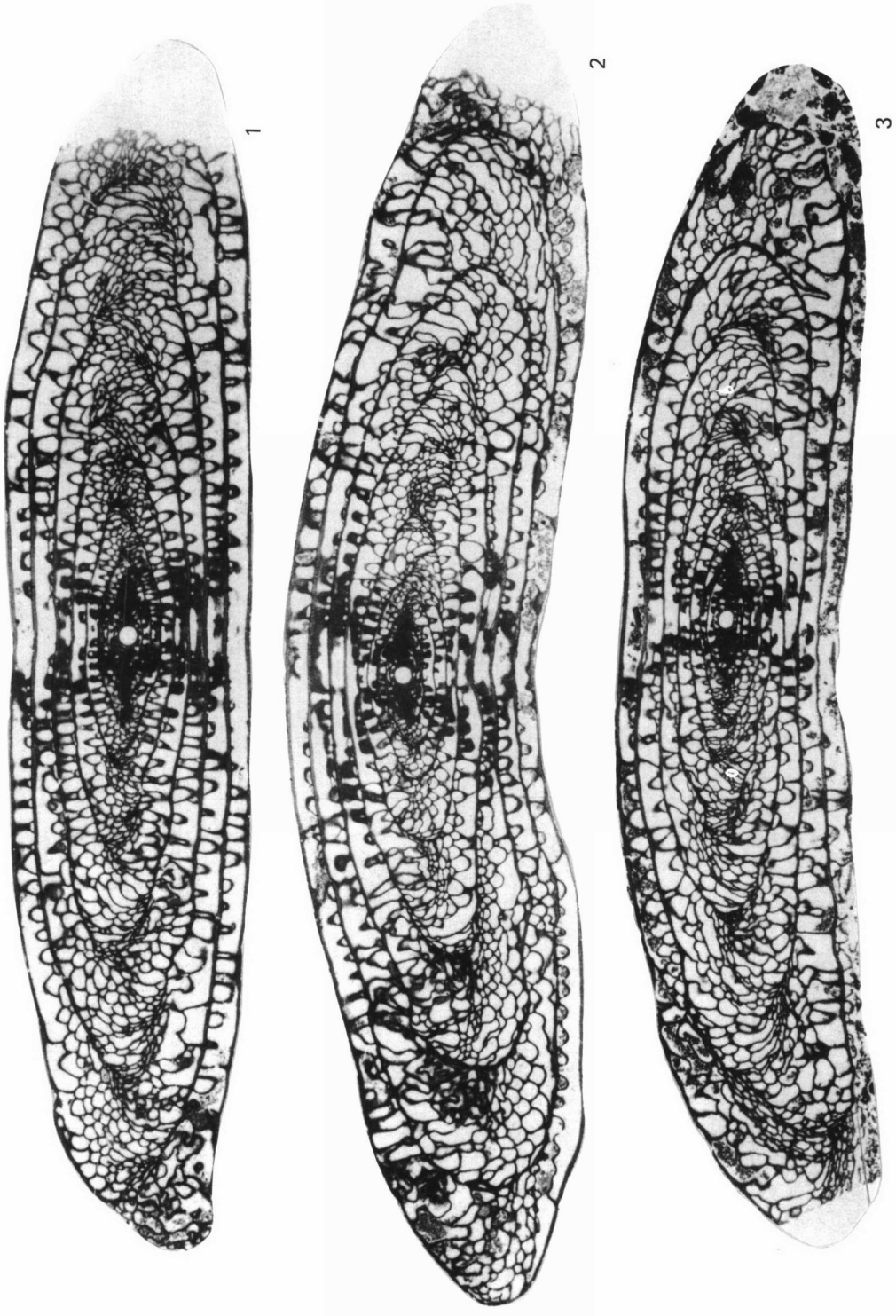
Parafusulina (Skinnerella) magna



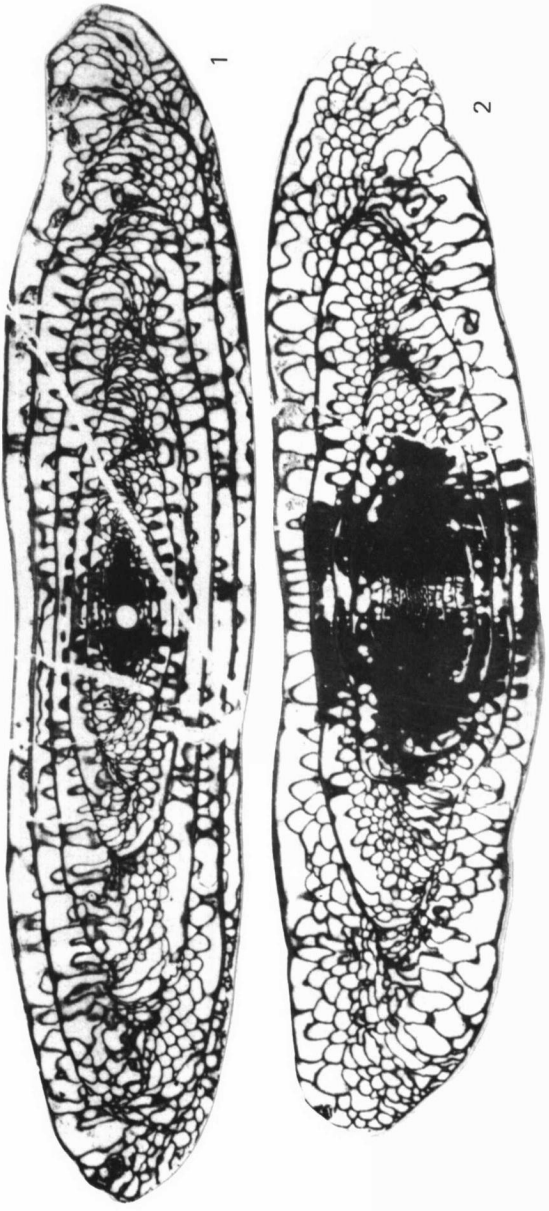
Parafusulina (Skinnerella) magna

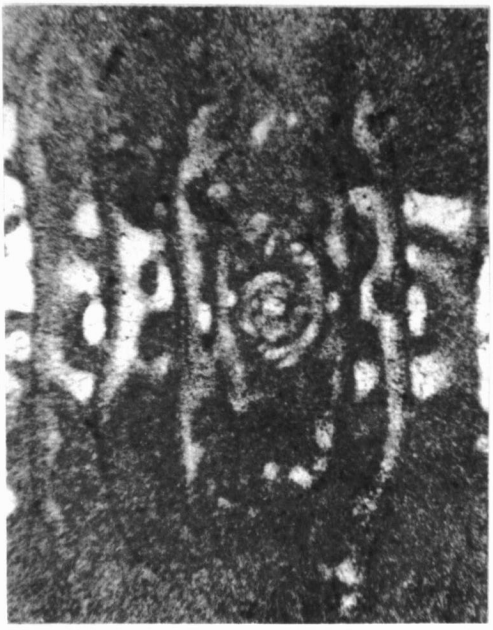


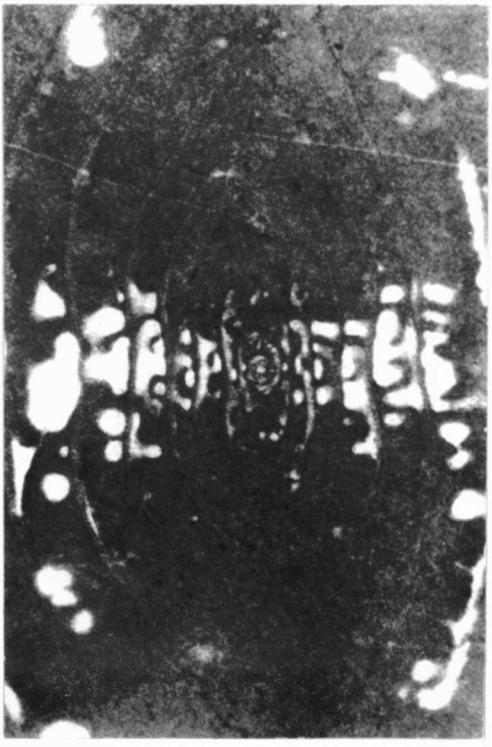
Parafusulina (Skinnerella) cylindrica



Parafusulina (Skinnerella) cylindrica

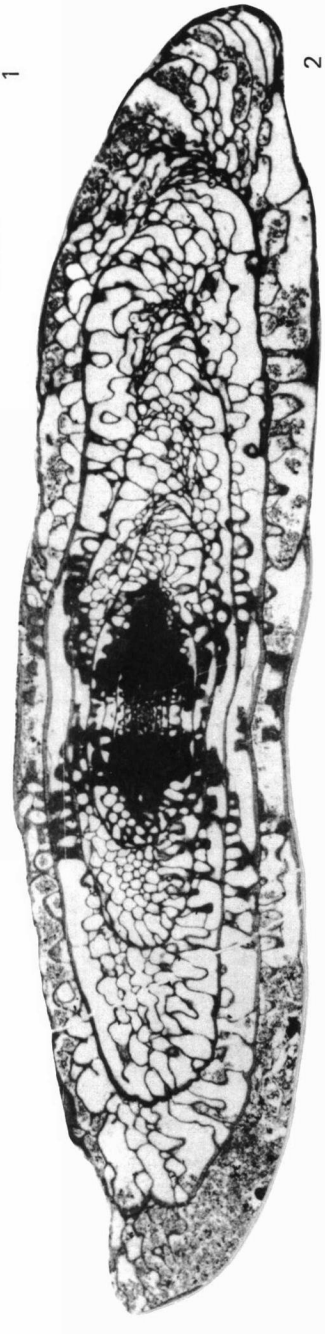






Parafusulina (Skinnerella) cylindrica

1



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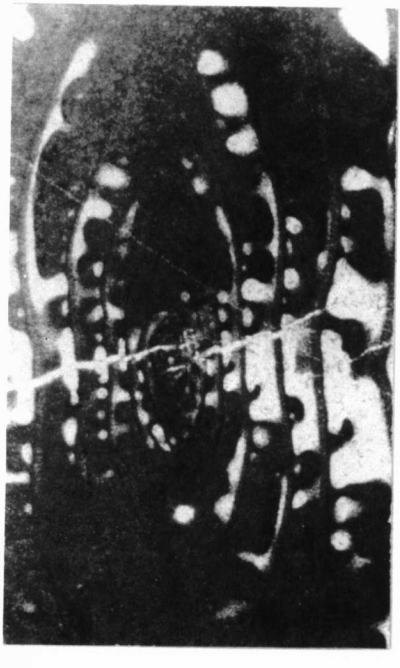

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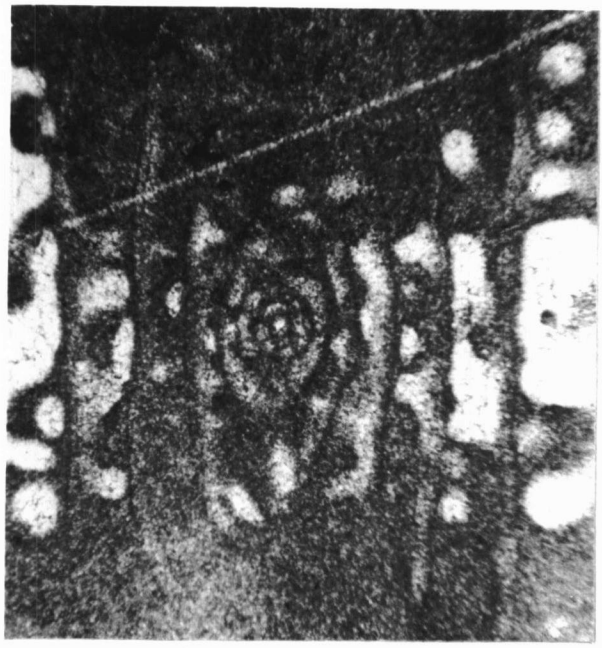

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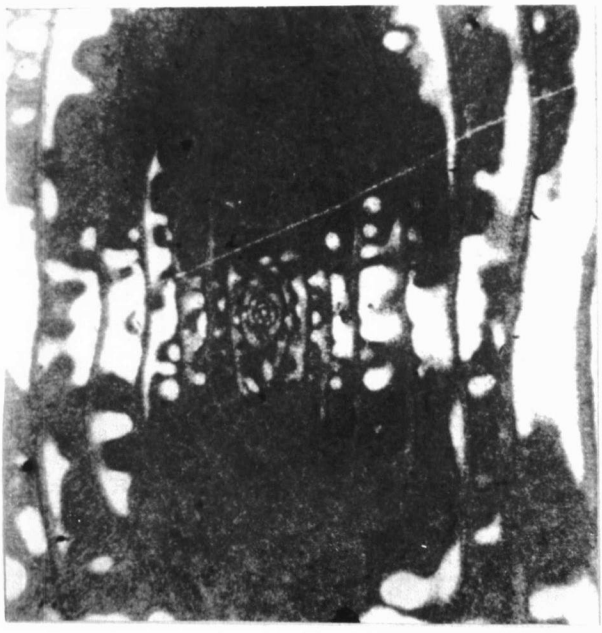

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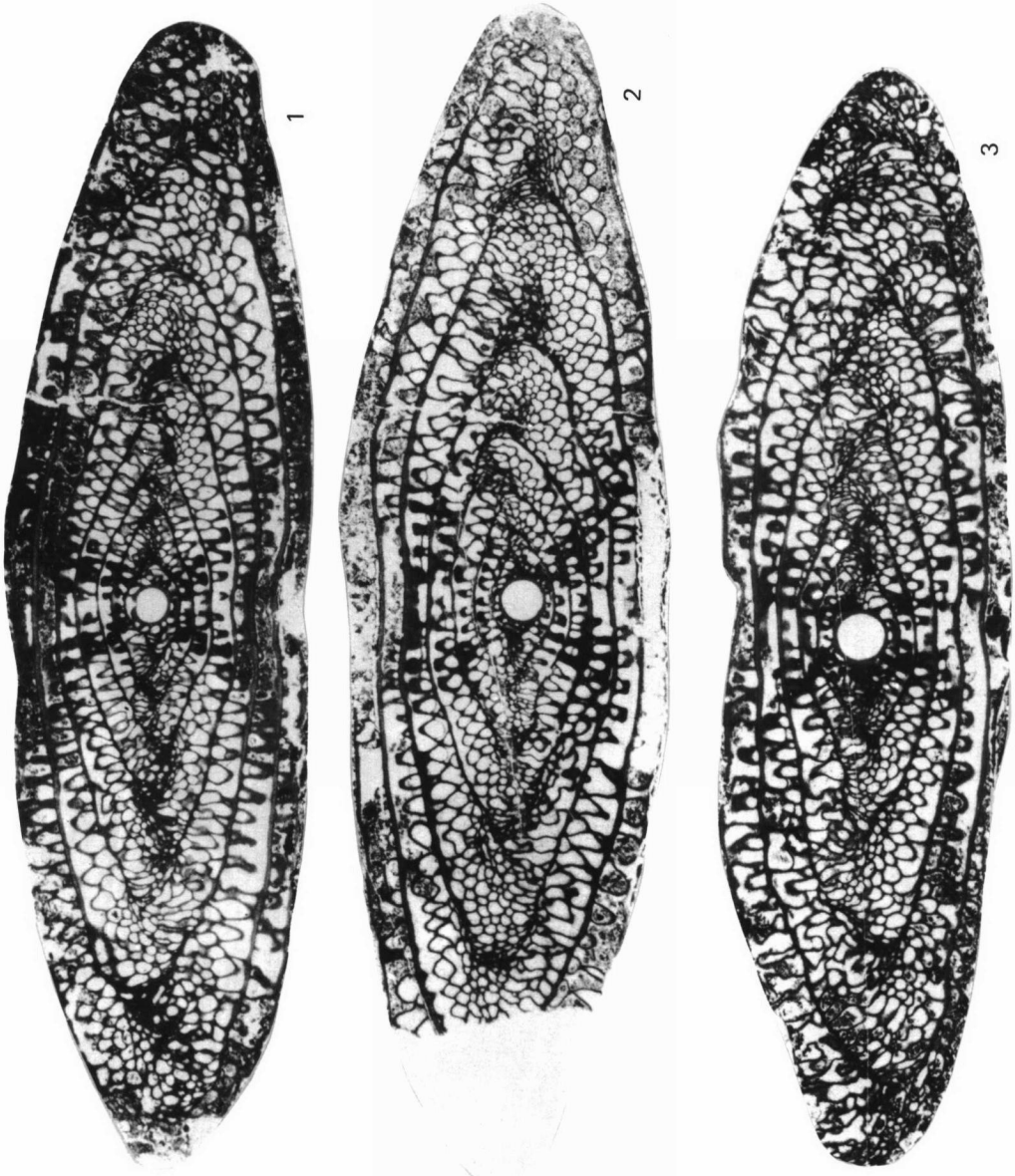

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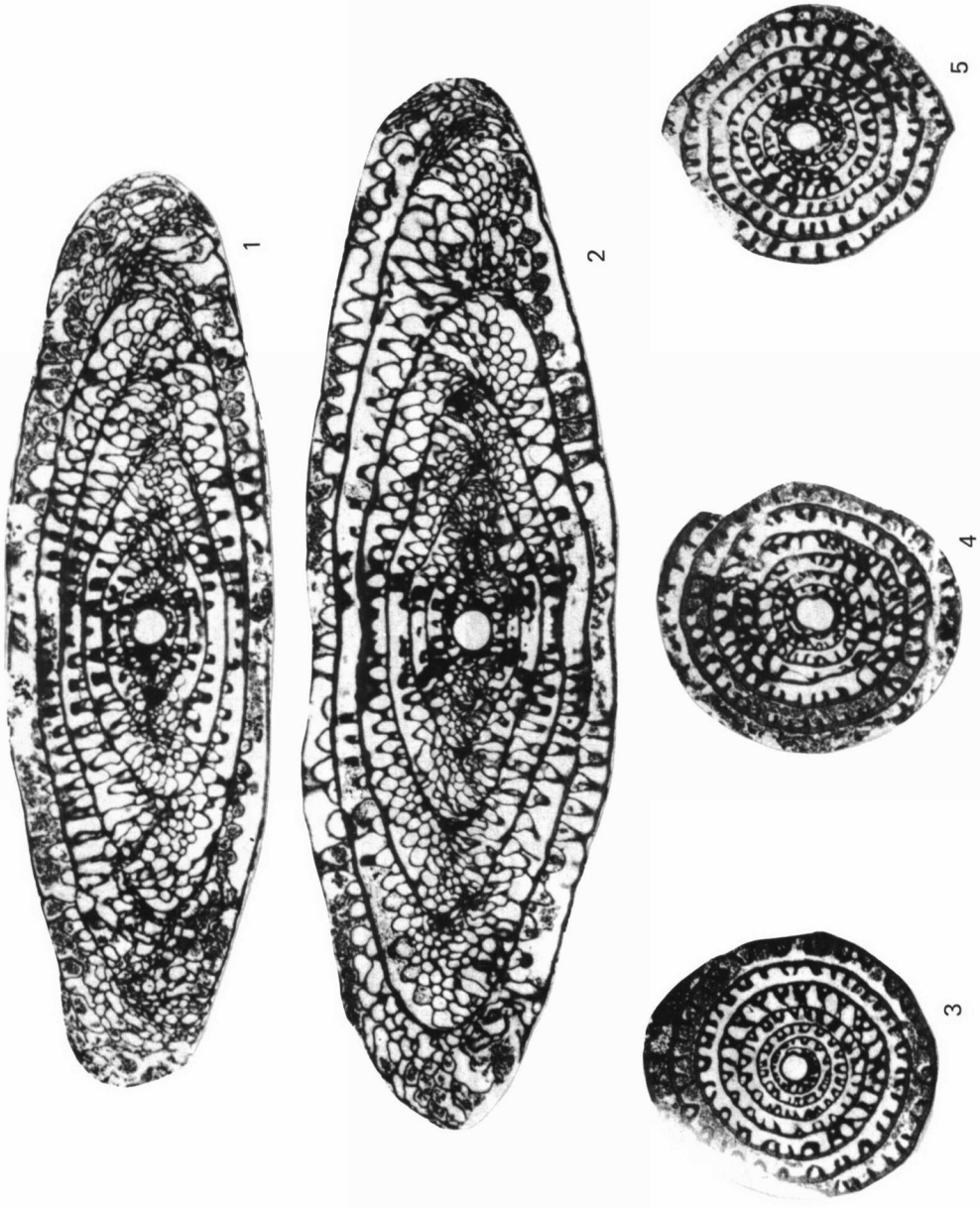

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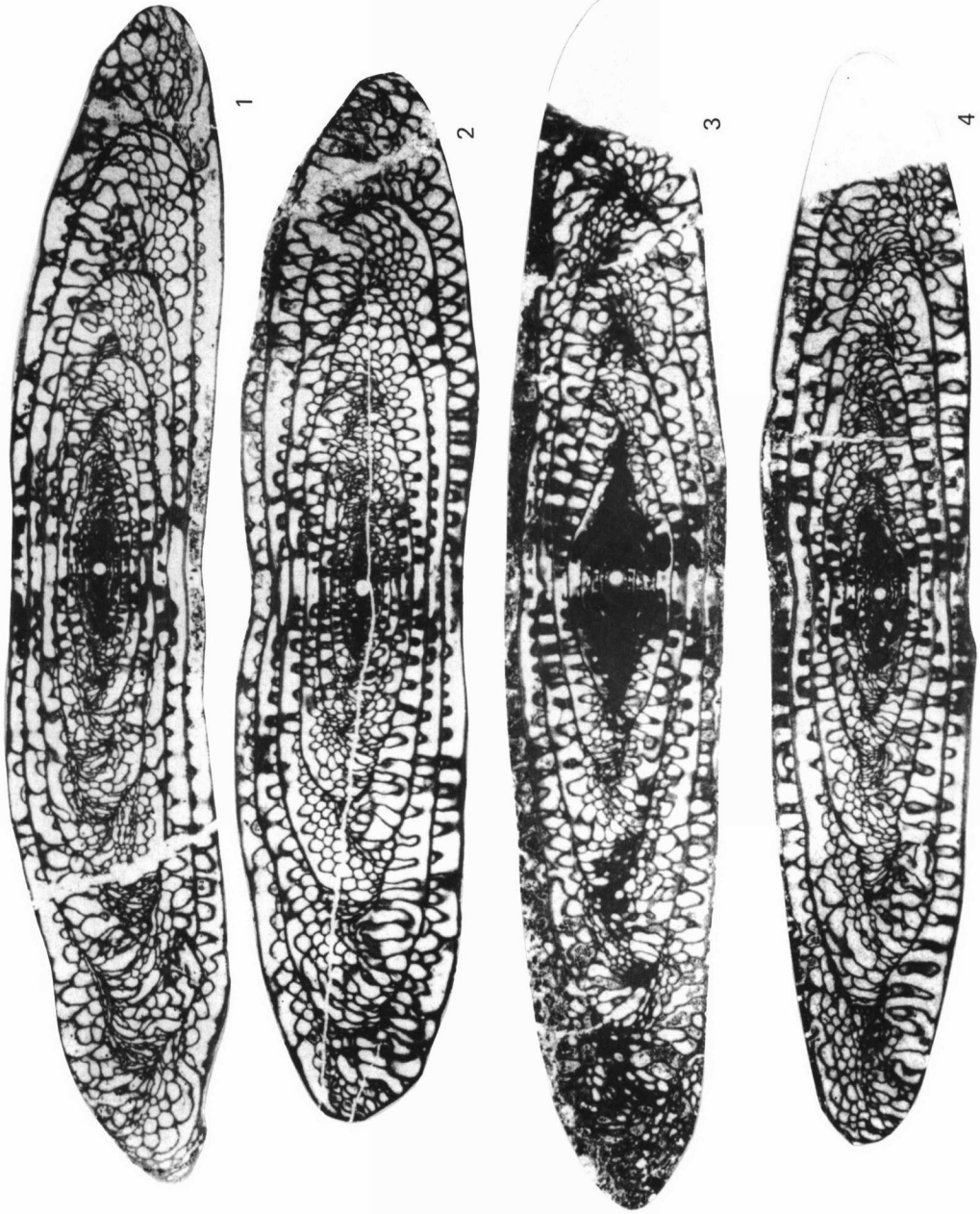

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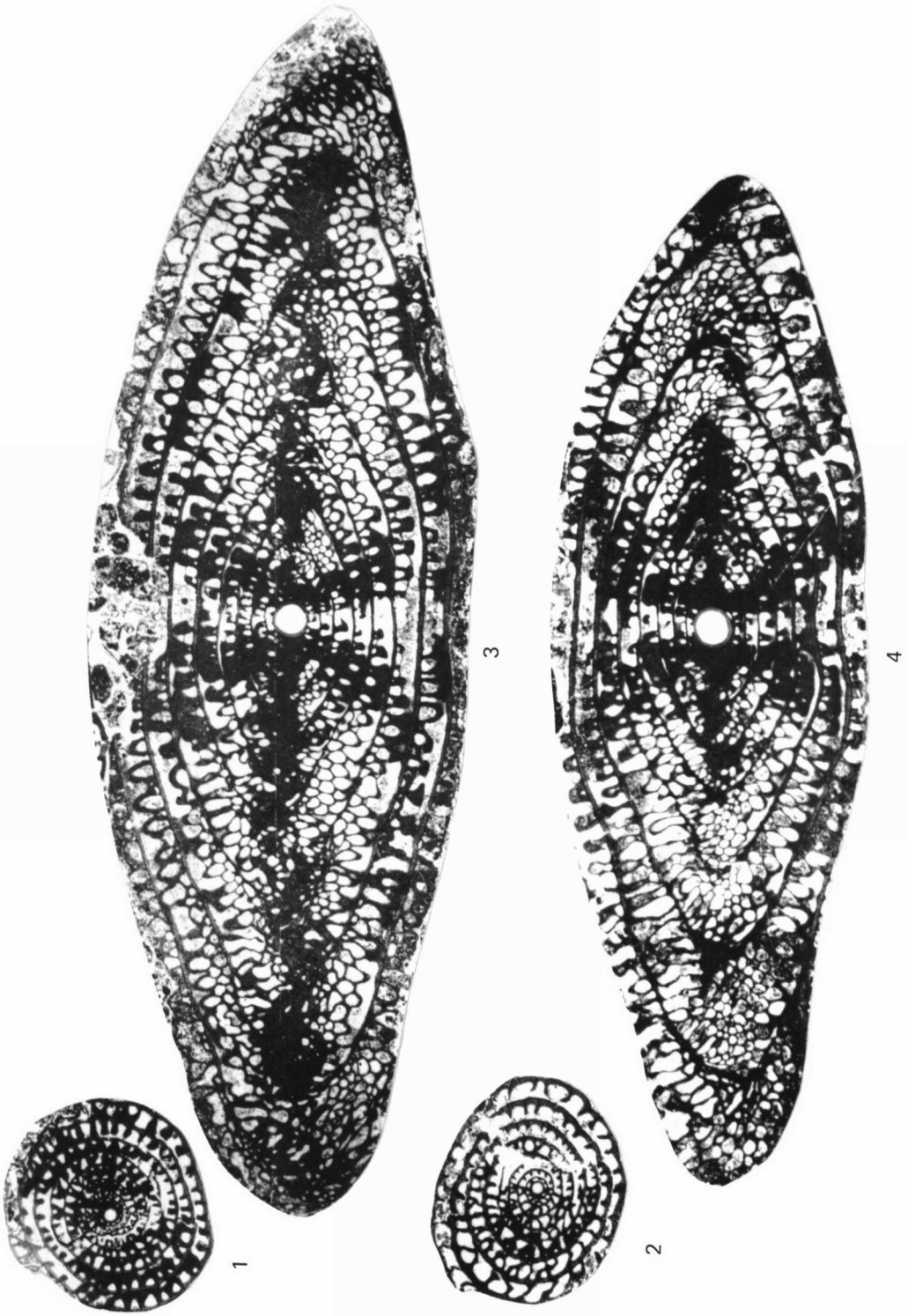
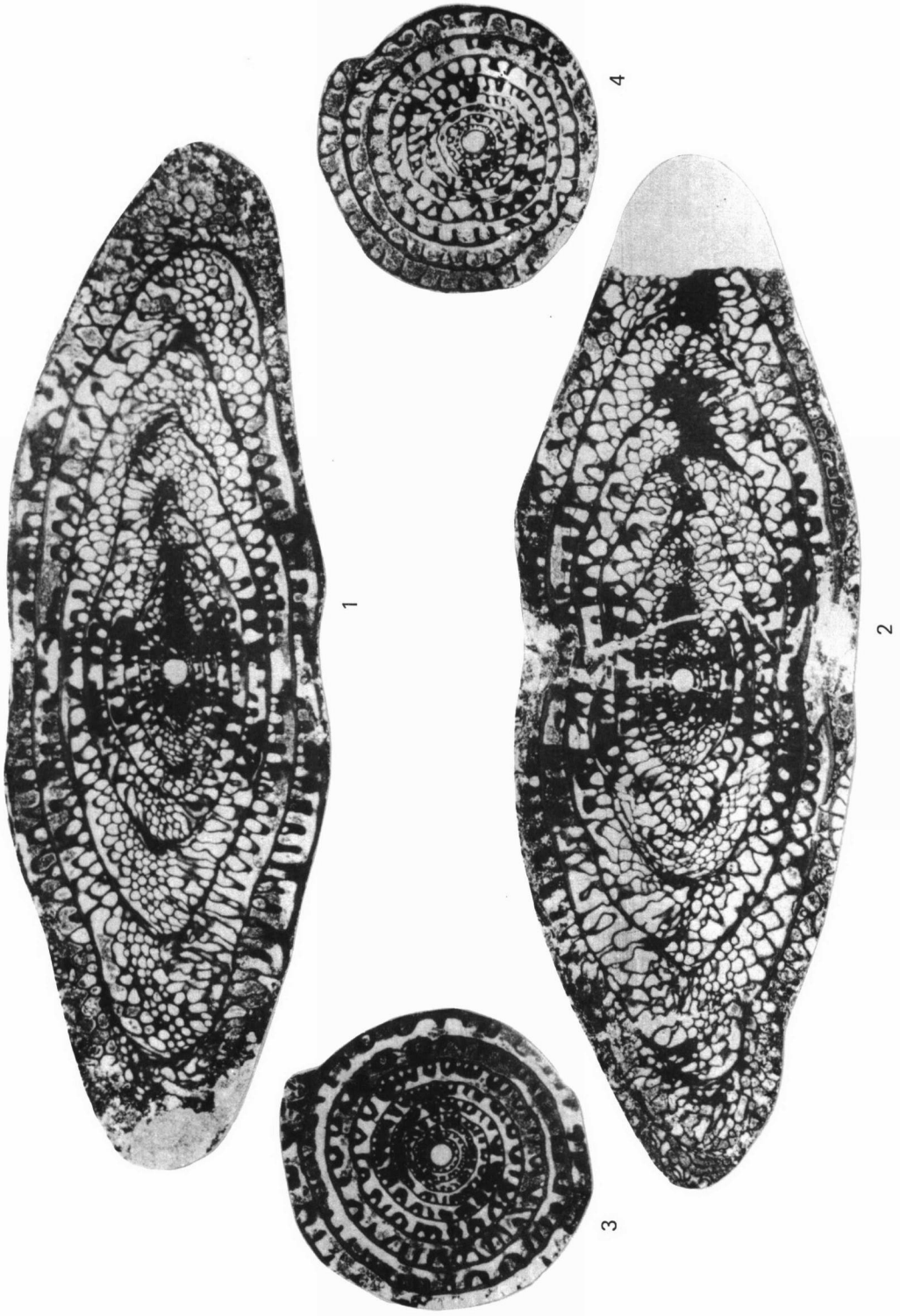


Parafusulina (Skinnerella) tenuis, 1-2
Parafusulina (Skinnerella) robusta, 3-4



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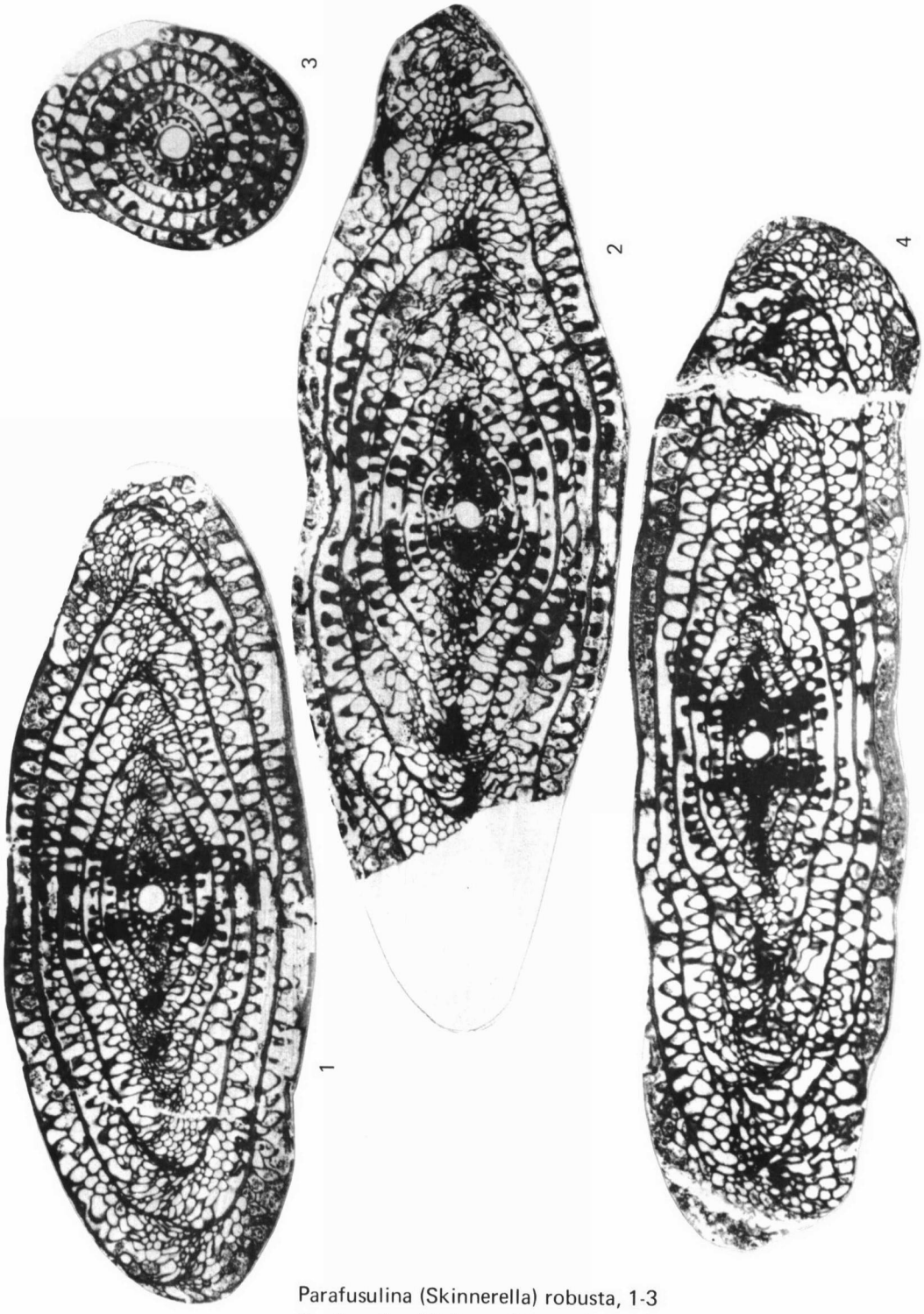
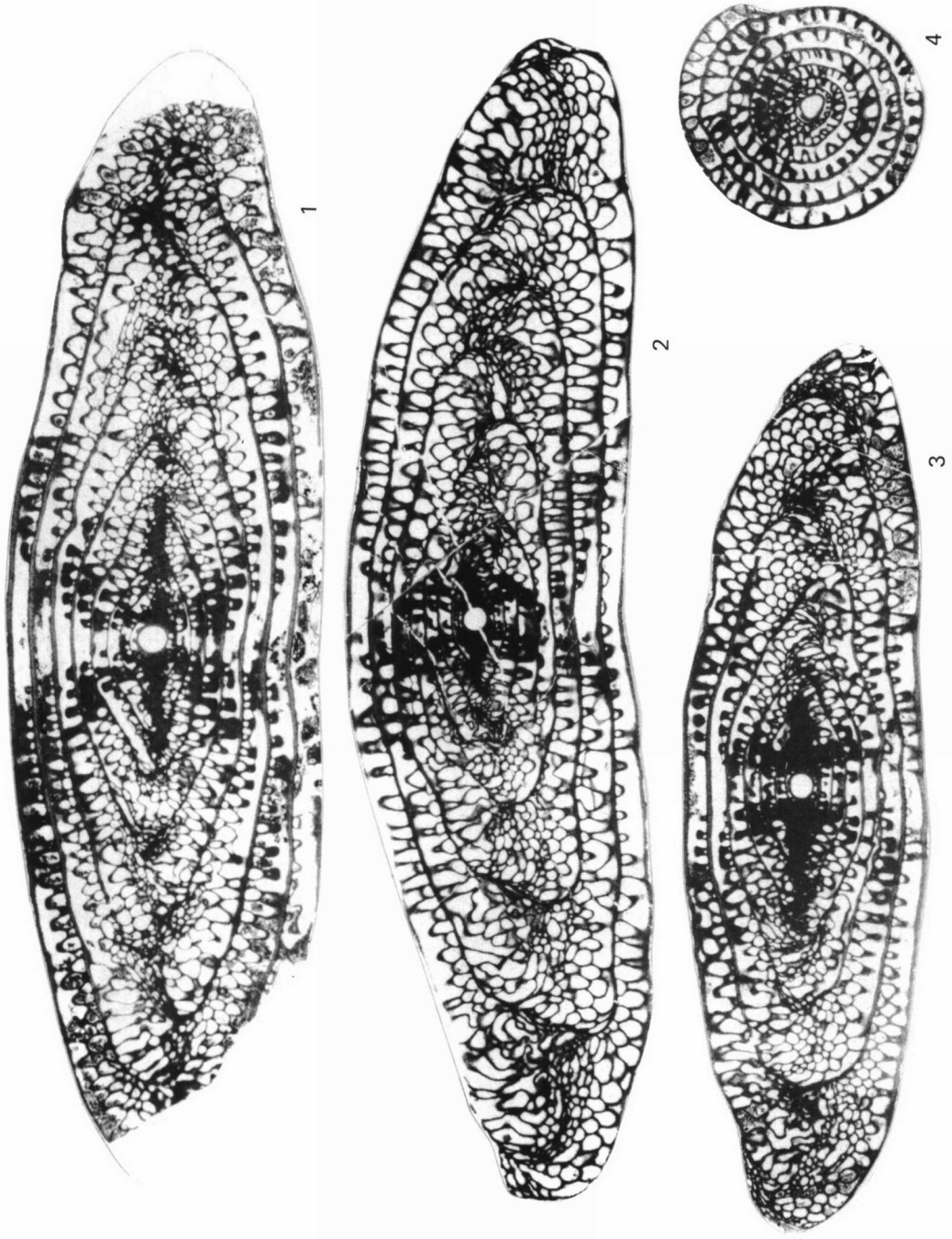
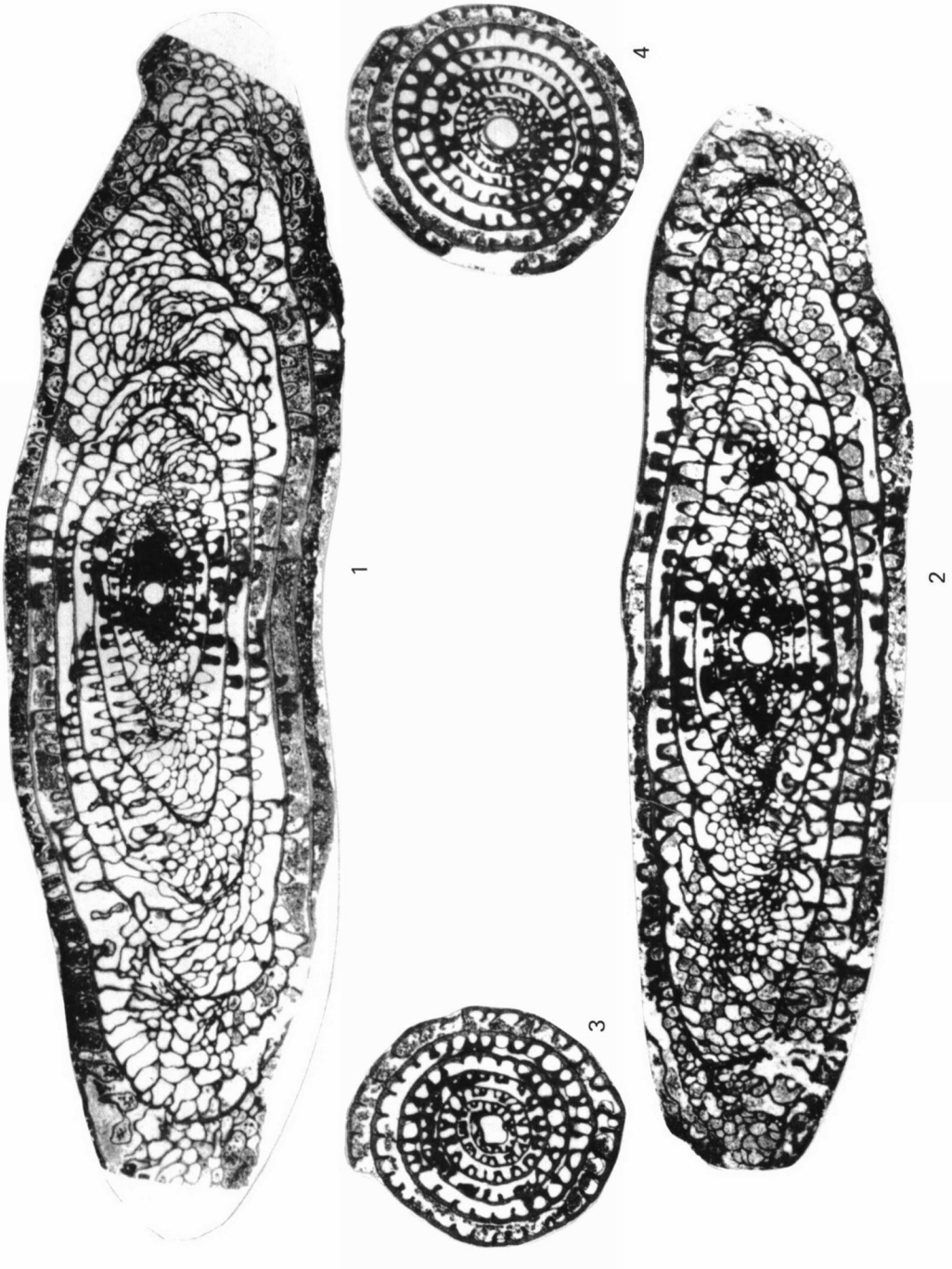


Parafusulina (Skinnerella) robusta, 1-3
Parafusulina (Skinnerella) speciosa, 4



Parafusulina (Skinnerella) speciosa



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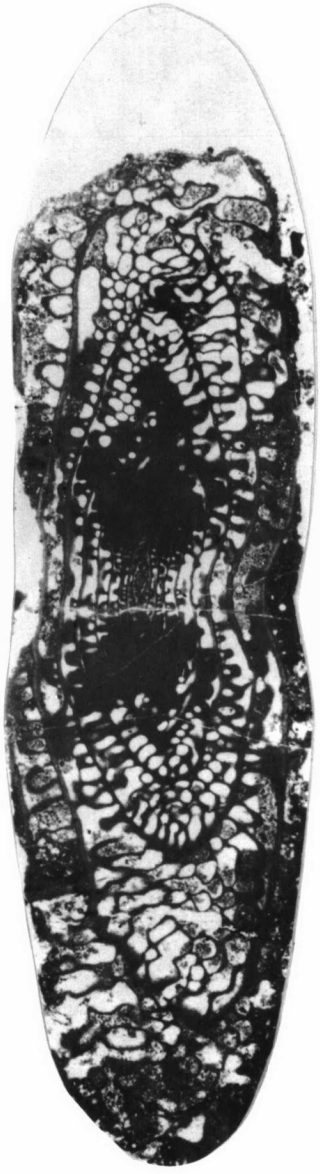

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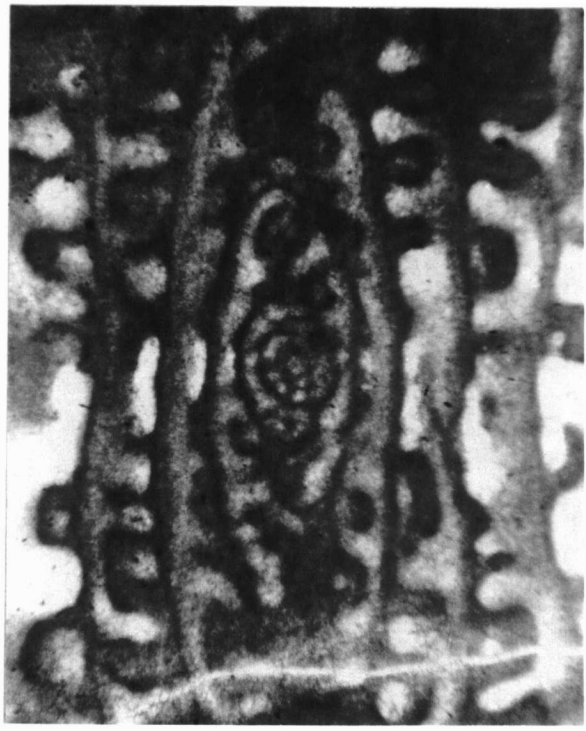

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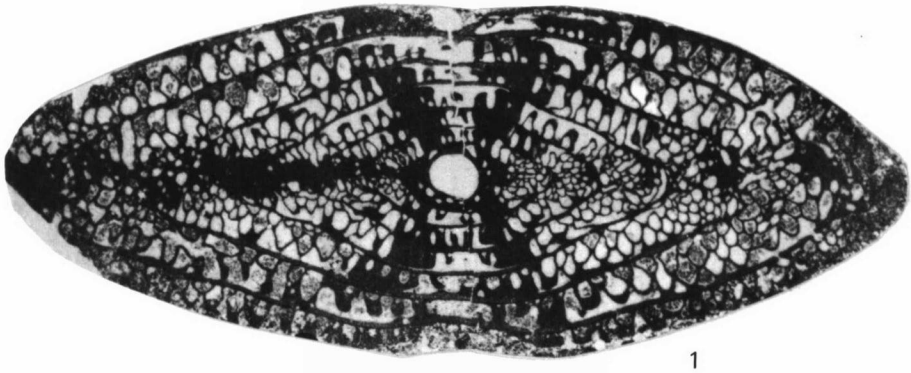
Parafusulina (Skinnerella) speciosa



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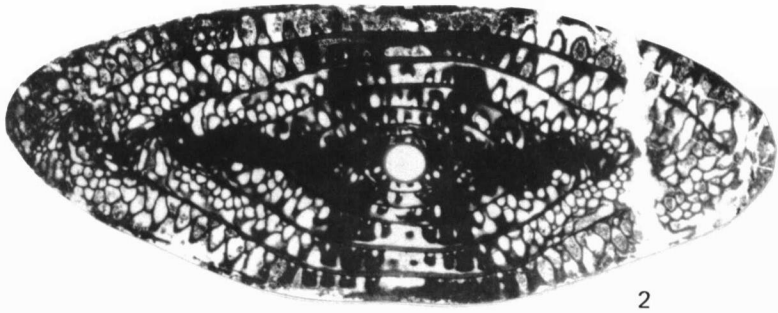

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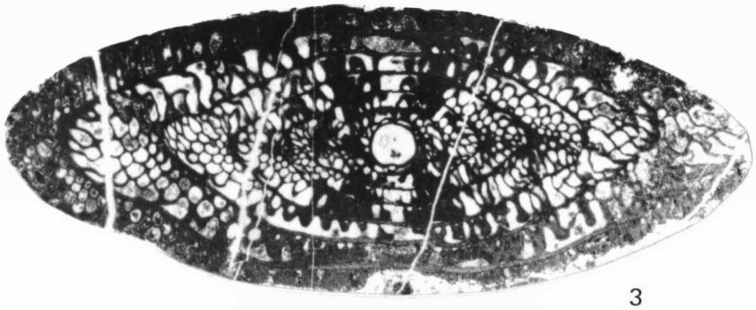

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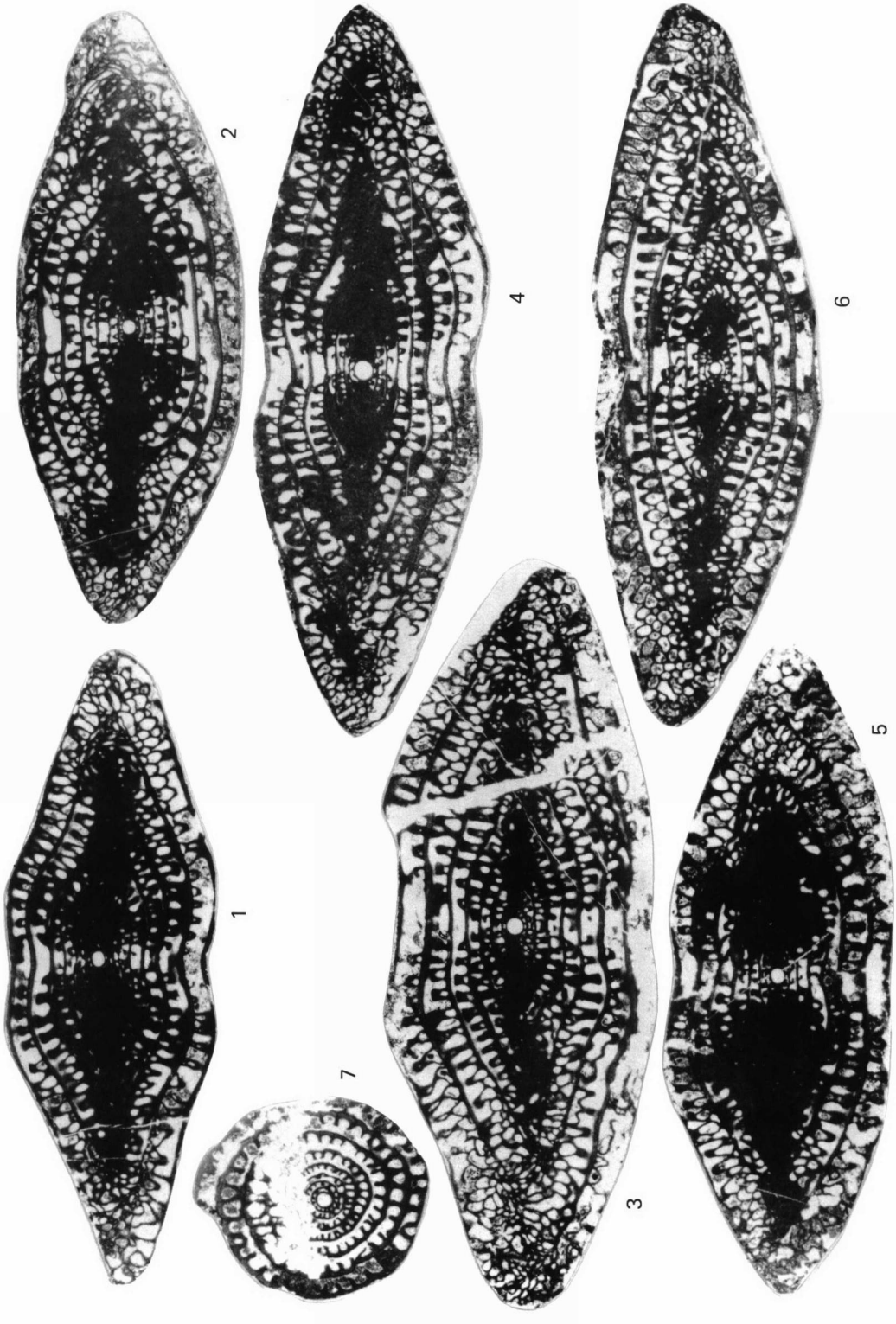
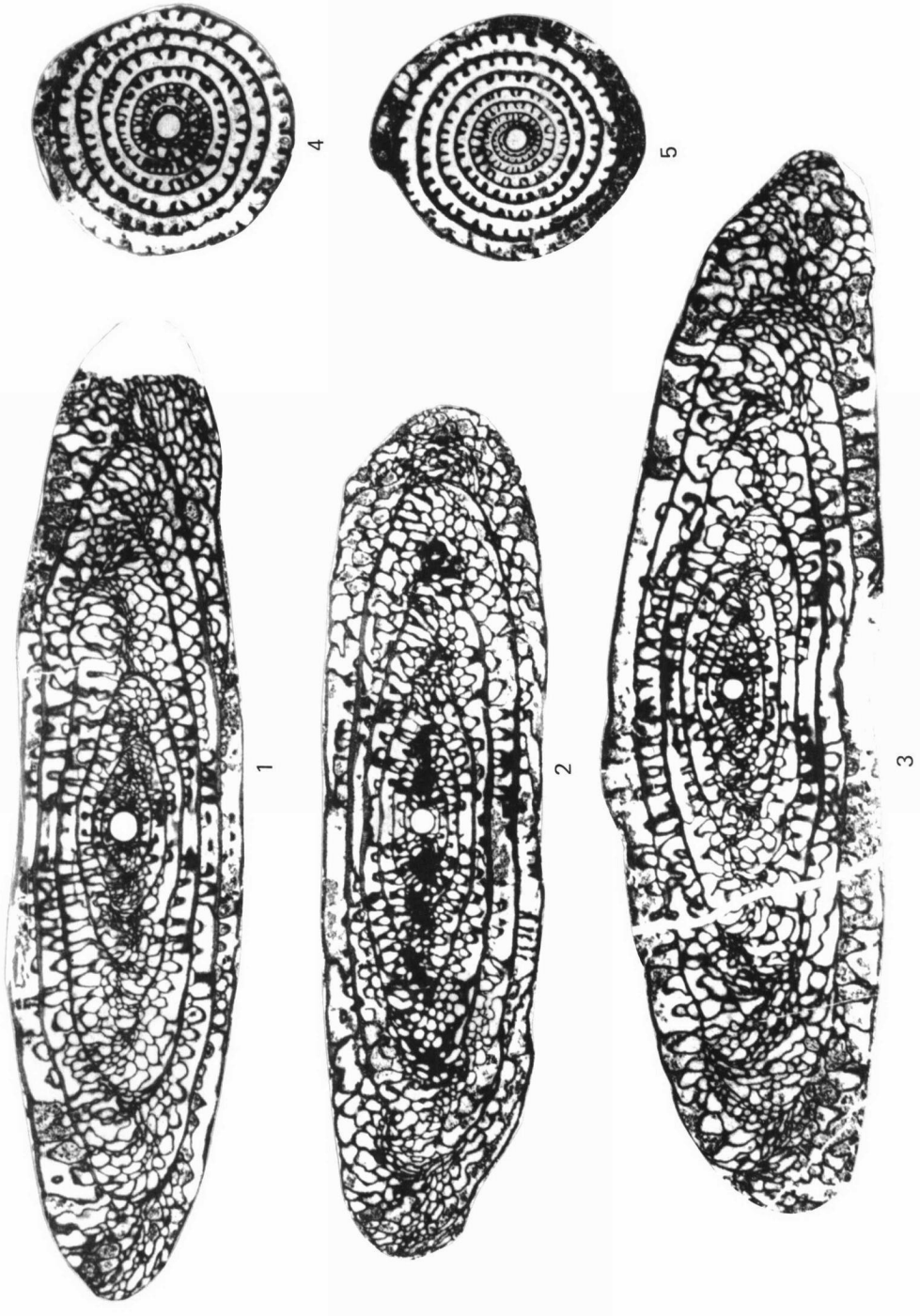
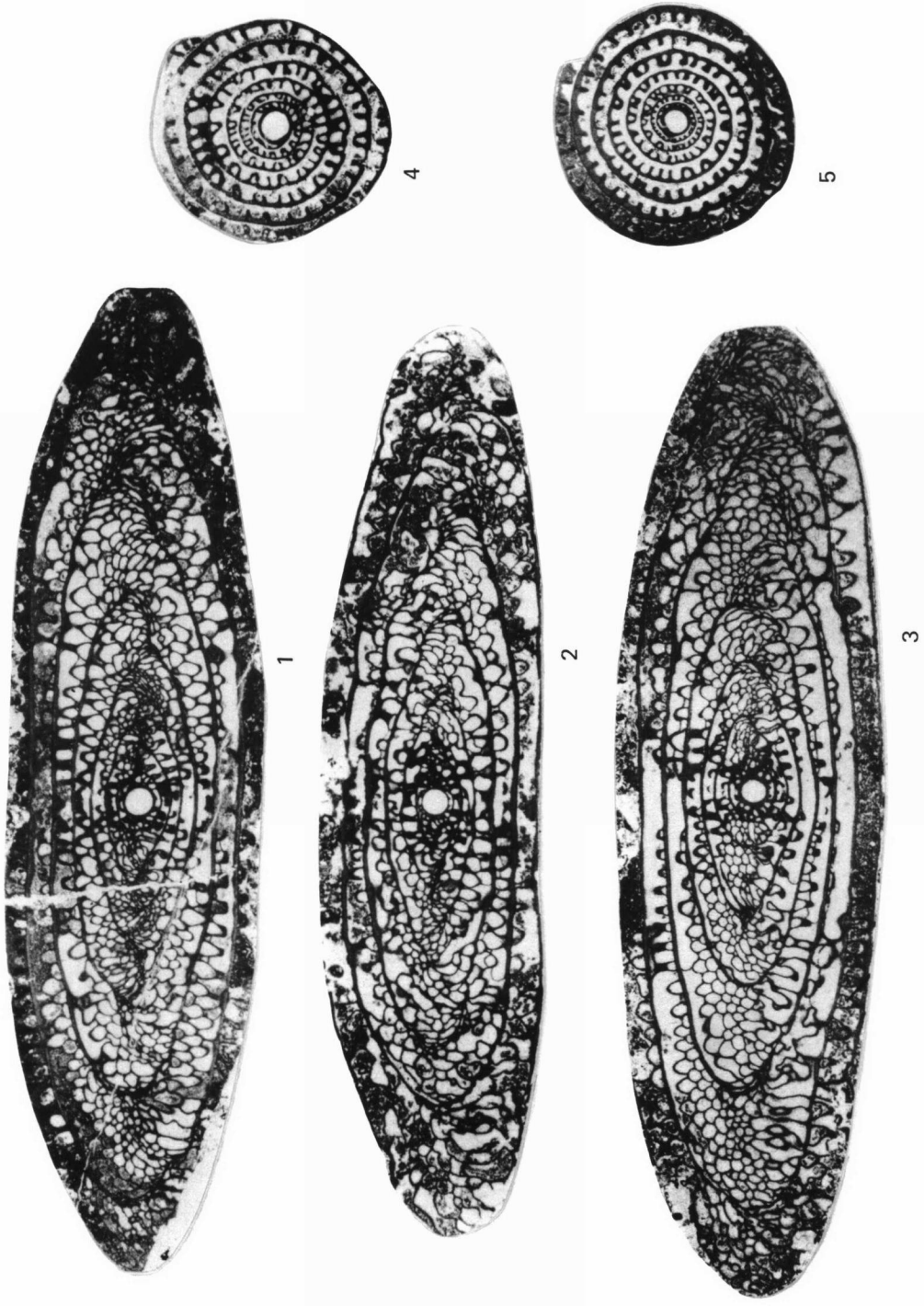
Parafusulina (Skinnerella) brevis



Parafusulina (Skinnerella) biconica



Parafusulina (Parafusulina) amoena



Parafusulina (Parafusulina) amoena

tively.——3-6. Sagittal sections of paratypes, 2,503,160-2,220. 1-2, 6 from coll. T-1007; 3, 5 from coll. T-537; 4 from coll. T-1005.

PLATE 8

FIGURE

1-3. *Parafusulina* (*Skinnerella*) *formosa* SKINNER, n. sp. Axial sections of holotype 2,503,163, and paratypes 2,503,164-5, all from coll. T-537.

PLATE 9

FIGURE

1-5. *Parafusulina* (*Skinnerella*) *formosa* SKINNER, n. sp. ——1-2. Axial sections of paratypes 2,503,166-7, from coll. T-1005.——3-5. Sagittal sections of paratypes 2,503,168-70, from coll. T-537.

PLATE 10

FIGURE

1-4. *Parafusulina* (*Skinnerella*) *tenuis* SKINNER, n. sp.——1. Axial section of holotype, 2,503,-171, from coll. T-1007.——2-4. Axial sections of paratypes 2,503,172-4; 2 from coll. T-1008; 3-4 from coll. T-537.

PLATE 11

FIGURE

1-2. *Parafusulina* (*Skinnerella*) *tenuis* SKINNER, n. sp. Sagittal sections of paratypes 2,503,-175-6, both from coll. T-537.

3-4. *Parafusulina* (*Skinnerella*) *robusta* SKINNER, n. sp.——3. Axial section of holotype, 2,503,-177, from coll. T-537.——4. Axial section of paratype 2,503,178, from coll. T-538.

PLATE 12

FIGURE

1-4. *Parafusulina* (*Skinnerella*) *robusta* SKINNER, n. sp.——1-2. Axial sections of paratypes 2,503,179-80, from coll. T-537.——3-4. Saggittal sections of paratypes 2,503,181-2; 3 from coll. T-538; 4 from coll. T-1005.

PLATE 13

FIGURE

1-3. *Parafusulina* (*Skinnerella*) *robusta* SKINNER, n. sp.——1-2. Axial sections of paratypes 2,503,183-4; 1 from coll. T-537; 2 from coll. T-1005.—3. Sagittal section of paratype 2,503,-185, from coll. T-537.

4. *Parafusulina* (*Skinnerella*) *speciosa* SKINNER, n. sp.——4. Axial section of holotype 2,503,-186, from coll. T-1007.

PLATE 14

FIGURE

1-4. *Parafusulina* (*Skinnerella*) *speciosa* SKINNER, n. sp.——1-3. Axial sections of paratypes 2,503,187-9, 1 from coll. T-1005; 2 from coll. T-1008; 3 from coll. T-538.——4. Sagittal section of paratype 2,503,190, from coll. T-538.

PLATE 15

FIGURE

1-4. *Parafusulina* (*Skinnerella*) *speciosa* SKINNER, n. sp.——1-2. Axial sections of paratypes 2,503,191-2; 1 from coll. T-1006; 2 from coll. T-538.——3-4. Sagittal sections of paratypes 2,503,193-4; 3 from coll. T-1005; 4 from coll. T-1007.

PLATE 16

FIGURE

1-3. *Parafusulina* (*Skinnerella*) *speciosa* SKINNER, n. sp.——1. Axial section of microspheric paratype, 2,503,195, from coll. T-1007.——2-3. Part of same specimen, ×40 and ×100, respectively.

PLATE 17

FIGURE

1-6. *Parafusulina* (*Skinnerella*) *brevis* SKINNER, n. sp.——1. Axial section of holotype 2,503,-196, from coll. T-537.——2-3. Axial sections of paratypes 2,503,197-8, from coll. T-538. ——4-6. Sagittal sections of paratypes 2,503,-199-201; 4 from coll. T-537; 5-6 from coll. T-1005.

PLATE 18

FIGURE

1-7. *Parafusulina* (*Skinnerella*) *biconica* SKINNER, n. sp.——1. Axial section of holotype 2,503,-202, from coll. T-1008.—2-6. Axial sections of paratypes 2,503,203-8; 2 from coll. T-1006; 3-5 from coll. T-1008; 6 from coll. T-1005.—— 7. Sagittal section of paratype 2,503,209, from coll. T-538.

PLATE 19

FIGURE

1-5. *Parafusulina* (*Parafusulina*) *amoena* SKINNER, n. sp.——1. Axial section of holotype 2,503,210, from coll. T-537.——2-3. Axial sections of paratypes, 2,503,211-2; 2 from coll. T-1005; 3 from coll. T-538.——4-5. Sagittal sections of paratypes 2,503,213-4; 4 from coll. T-538; 5 from coll. T-537.

PLATE 20

FIGURE

1-5. *Parafusulina* (*Parafusulina*) *amoena* SKINNER, n. sp.——1-3. Axial sections of paratypes 2,503,215-7; 1, 3 from coll. T-537; 2 from coll. T-1005.——4-5. Sagittal sections of paratypes 2,503,218-9, from coll. T-537.

PARAFUSULINA (SKINNERELLA) SPECIOSA
Skinner, n. sp.

Plate 13, figure 4; Plate 14, figures 1-4;
Plate 15, figures 1-4; Plate 16, figures 1-3

Shell large, subcylindrical, with bluntly rounded poles. Mature individuals have 7.5 to 8.5 volutions, rarely 9. Such specimens measure 15.1 to 17.0 mm in length, and 3.9 to 4.6 mm in diameter. Form ratio varies from 3.55 to 4.12.

Spirotheca, composed of tectum and keriotheca, measures 68 to 79 μ in thickness in the 7th volution. Septa intensely fluted from pole to pole; septal folds high, commonly reaching tops of chambers. Secondary deposits, coating both surfaces of the septa, are well developed in zones on either side of the tunnel and, to a lesser extent, along the axis of coiling. In these zones septal loops appear squared off as seen in axial sections and markedly thickened across the tops; such loops are commonly wider at tops than at bases. Septa number 17 to 18 in 1st whorl, 25 to 30 in 2nd, 32 to 33 in 3rd, 32 to 38 in 4th, 32 to 40 in 5th, 34 to 45 in 6th, and about 43 in 7th. Low, narrow cuniculi are present in outer volutions. Phrenothecae well developed.

Proloculus large, its outside diameter varying from 364 to 536 μ, averaging about 440 μ. Tunnel rather narrow, tunnel angle measuring 32° to 39° in seventh volution. Chomata present only on proloculus.

A single axial section of a microspheric individual was found in these collections. It has 11 volutions and measures 15.6 mm in length, and 3.7 mm in diameter. Form ratio is 4.22. The first 2 volutions constitute a discoidal juvenarium, coiled askew to the later whorls. Early volutions tightly coiled, and spirotheca markedly thinner than in megalospheric specimens; thickness of spirotheca in 7th whorl measures 43 μ. Fluting of septa comparable to that of megalospheric form, but development of secondary deposits markedly greater, nearly filling the shell in the first 7 volutions. Proloculus minute, its outside diameter measuring only 36μ. Tunnel comparable to that of megalospheric individuals; in the 7th whorl the tunnel angle measures 34°. Chomata present only in juvenarium.

Discussion.—*Parafusulina* (*Skinnerella*) *speciosa* Skinner, n. sp., more nearly resembles *P.* (*S.*) *skinneri* Dunbar from Sonora, Mexico, than any other known species. The latter, however, has a generally smaller proloculus, less numerous septa, and its secondary deposits are more widely distributed throughout the shell.

Occurrence.—This species is common in all six of the collections studied.

Types.—Holotype, KUMIP 2,503,186 (Pl. 13, fig. 4). Paratypes, KUMIP 2,503,187-95 (Pl. 14, fig. 1-4; Pl. 15, fig. 1-4; Pl. 16, fig. 1-3).

PARAFUSULINA (SKINNERELLA) BREVIS
Skinner, n. sp.

Plate 17, figures 1-6

Shell large, thickly fusiform, with bluntly pointed poles. Mature specimens have 6.5 to 7 volutions and measure 10.0 to 12.0 mm in length, and 3.8 to 4.6 mm in diameter. Form ratio varies from 2.59 to 2.63.

Spirotheca, composed of tectum and keriotheca measures 79 to 97 μ in thickness in 6th whorl. Septa intensely fluted throughout shell; septal folds high, commonly extending to tops of chambers. Secondary deposits, coating both faces of septa, are well developed in zones on either side of tunnel, and to a lesser extent along axis of coiling. In these zones septal loops appear squared off as seen in axial sections and thickened across tops. Such loops are commonly wider at top than at base. Septa number 14 to 18 in 1st volution, 27 to 30 in 2nd, 24 to 31 in 3rd, 22 to 39 in 4th, 35 to 44 in 5th, 44 to 57 in 6th, and about 51 in 7th. Low narrow cuniculi are present in middle part of shell in outer volutions. Phrenothecae well developed.

Proloculus large, its outside diameter ranging from 526 to 745 μ, averaging about 620 μ. Tunnel narrow, tunnel angle measuring 25° to 27° in the 6th volution. Chomata present only on proloculus.

Discussion.—*Parafusulina* (*Skinnerella*) *brevis* Skinner, n. sp., resembles *P.* (*S.*) *sonoraensis* Dunbar in size and shape. It differs from that species in its larger proloculus, generally more numerous septa, and fewer whorls. *P.* (*S.*) *brevis* at 7 volutions is almost exactly the same size as *P.* (*S.*) *sonoraensis* at 8 or 9.

Occurrence.—This is a relatively rare species, only a few specimens having been found in collections T-537, T-538, and T-1005.

TYPES.—Holotype, KUMIP 2,503,196 (Pl. 17, fig. 1). Paratypes, KUMIP 2,503,197-201 (Pl. 17, fig. 2-6).

PARAFUSULINA (SKINNERELLA) BICONICA
Skinner, n. sp.

Plate 18, figures 1-7

Shell moderately large, fusiform, with straight to slightly concave or convex lateral slopes and rather sharply pointed poles. Middle portion of shell commonly somewhat constricted. Mature individuals have 7 to 7.5 volutions and measure 9.3 to 12.0 mm in length, and 3.0 to 3.5 mm in sagittal diameter. Form ratio varies from 2.73 to 3.44, averaging about 3.20.

Spirotheca, composed of tectum and keriotheca, measures 62 to 82 μ in thickness in 7th whorl. Septa intensely fluted from pole to pole; septal folds high, commonly extending to tops of chambers. Secondary deposits, coating both surfaces of septa, strongly developed in zones on either side of tunnel and along axis of coiling. Septal loops, as seen in axial sections, appear squared off and markedly thickened across tops; such loops are commonly wider at top than in lower portion. Septal count for the 1st to 7th whorls of a typical specimen is 11, 15, 23, 30, 32, 34, and 36. Low narrow cuniculi are present in central part of shell in outer volutions. Phrenothecae present, but usually not conspicuous.

Proloculus moderate in size, its outside diameter varying from 202 to 318 μ, averaging about 265 μ. Tunnel narrow, tunnel angle measuring 27° to 34° in 7th volution. Chomata present only on proloculus.

DISCUSSION.—*Parafusulina* (*Skinnerella*) *biconica* SKINNER, n. sp., resembles *P.* (*S.*) *diabloensis* DUNBAR & SKINNER in shape, but differs from that species in its smaller size, thinner spirotheca, and much smaller proloculus.

OCCURRENCE.—This species is sparingly common in collections T-537, T-538, T-1005, T-1006, and T-1007.

TYPES.—Holotype, KUMIP 2,503, 202 (Pl. 18, fig. 1). Paratypes, KUMIP 2,503,203-9 (Pl. 18, fig. 2-7).

PARAFUSULINA (PARAFUSULINA) AMOENA
Skinner, n. sp.

Plate 19, figures 1-5; Plate 20, figures 1-5

Shell large, subcylindrical, with bluntly rounded poles. Fully grown individuals have 6 to 7 volutions, rarely 8. Such specimens measure 12.0 to 14.5 mm in length, and 3.0 to 3.7 mm in diameter. Form ratio varies from 3.65 to 4.23, averaging about 3.95.

Spirotheca, composed of tectum and keriotheca, measures 62 to 81 μ in thickness in the 6th whorl. Septa strongly but somewhat irregularly folded throughout shell. Septal folds high, commonly reaching tops of chambers. Septal loops, as seen in axial sections, usually rounded at tops. Secondary deposits present, but weakly and irregularly developed and not conspicuous. Septa number 14 to 19 in 1st volution, 22 to 30 in 2nd, 28 to 37 in 3rd, 29 to 35 in 4th, 31 to 36 in 5th, 32 to 41 in 6th, 37 to 40 in 7th, and about 43 in 8th. Low cuniculi present throughout most of shell in outer whorls, but observed only adjacent to tunnel in earlier ones. Phrenothecae well developed.

Proloculus large but rather variable in size, its outside diameter ranging from 363 to 504 μ, averaging about 430 μ. Tunnel rather wide, tunnel angle in 6th volution measuring 42° to 51°. Weak chomata present only on proloculus.

DISCUSSION.—*Parafusulina* (*Parafusulina*) *amoena* SKINNER, n. sp., is a rather primitive member of the genus, as evidenced by the comparatively poor development of its cuniculi. It bears some resemblance to *P. bakeri* DUNBAR & SKINNER, but differs from that species in its more slender shape, smaller size, smaller proloculus, and lesser development of secondary deposits. *P.* (*P.*) *amoena* is also similar to *P. leonardensis* Ross, differing from the latter in its generally larger proloculus and the much weaker development of secondary deposits. Also, the septal fluting is much less regular than in *P. leonardensis*.

OCCURRENCE.—This species is common in collections T-537, T-538, T-1005, T-1006, and T-1007.

TYPES.—Holotype, KUMIP 2,503,210 (Pl. 19, fig. 1). Paratypes, KUMIP 2,503,211-9 (Pl. 19, fig. 2-5; Pl. 20, fig. 1-5).

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